NATUR VÅRDS VERKET

SWEDISH ENVIRONMENTAL PROTECTION AGENCY

EUSBSR EU STRATEGY FOR THE BALTIC SEA REGION

POLICY AREA 'HAZARDS'

PFAS
in the Baltic Sea Region

Inventory of awareness, actions and strategies related to highly fluorinated substances, PFAS, including PFOS

Sara Sahlin

October 2017

Interreg Baltic Sea Region

EUROPEAN UNION

EUROPEAN REGIONAL DEVELOPMENT FUND

Sahlin, S. (2017). PFAS in the Baltic Sea Region. Inventory of awareness, actions and strategies related to highly fluorinated substances, PFAS, including PFOS. Policy Area Hazards, EUSBSR, Swedish Environmental Protection Agency.

The report is available for download at www.swedishepa.se/hazards or contact Jenny Hedman jenny.hedman@naturvardsverket.se.

Cover photo: David Hamp/Etsabild

Preface

Policy Area (PA) Hazards within the EU Strategy for the Baltic Sea Region (EUSBSR) is a platform for regional cooperation, aiming to prevent pollution and reduce the use of hazardous substances. PA Hazards contributes to regional policy development and provides a link between regional policy and local measures to reduce emissions of hazardous substances to the Baltic Sea.

Due to an identified common interest among the Baltic Sea countries and to inform national and regional policy development stakeholders, PA Hazards has performed an inventory of the awareness, actions and strategies related to highly fluorinated substances (PFAS) in the environment in all EU-Baltic Sea Region countries. Based on voluntary participation, this inventory collected information regarding knowledge and awareness of the emerging threat posed by PFAS to human health and the environment, national policies, and measures already taken or planned regarding PFAS-pollution within the region. No data collection has been done in this inventory, instead the focus has been to give an overview of PFAS-related policy discussions in each country. Information has been provided by different stakeholders, including national ministries and authorities as well as rescue services and defense forces.

The report has been prepared by Sara Sahlin at the Swedish Environmental Protection Agency, SEPA, for PA Hazards. Conclusions made by the author do not necessarily reflect the opinion of SEPA. PA Hazards is coordinated by SEPA on behalf of the Swedish government. The report was funded by SEPA and the European Union (European Regional Development Fund) Interreg Baltic Sea Region.

Stockholm, 2017-10-01

Jenny Hedman

Policy Area Coordinator Hazards
Swedish Environmental Protection Agency
www.swedishepa.se/hazards

Content

Summary

Per-and poly fluoroalkyl substances (PFAS) are hazardous to human health and the environment as many of them are toxic, bioaccumulative and highly persistent in the environment. PFAS have been widely used in various industrial and consumer applications since the 1950s. Today about 3000 different PFAS substances are used, of which PFOS and PFOA are the most well-known and widely spread in the environment. Since 2008, the use of PFOS is restricted within the EU and PFOA is identified as a substance of very high concern according to the European Chemicals Agency (ECHA). PFOS and PFOA (and substances that can degrade into PFOS and PFOA) are being replaced with other PFAS-substances, however, these replacements are often equally persistent, and their inherent toxicity is often unknown.

Fire-fighting foams containing PFAS, often referred to as AFFFs, are mainly used in so called class B fires, e.g. fires of oil, diesel, alcohol and plastics. At fire training sites, the use of PFAS-containing firefighting foams may contaminate soils, which eventually can spread to groundwater and surface water, posing a threat to both the environment as well as human health due to the contamination of drinking water and fish.

This inventory summarizes awareness, actions and national strategies related to PFAS in the environment in all EU-Baltic Sea Region (BSR) countries. The aim is to inform national and regional policy development stakeholders about current knowledge and measures taken on a national level related to the emerging issue of PFAS in the environment. It includes information about the use of PFAS-containing firefighting foams, the availability of environmental data, and implemented or planned measures related to contaminated soil, groundwater and drinking water. All EU-Baltic Sea Countries (SE, DK, DE, FI, PL, EE, LV, LT) were invited to voluntarily participate to the inventory by filling in questionnaires sent via email, and answering follow-up questions.

SE, DK, DE and FI are in general discussing and handling PFAS in a broader picture. This includes e.g. national recommendations and restrictions when using foams (SE, DE, FI), inventories of contaminated soils and groundwater, and extended environmental monitoring (or reoccurring screenings). No specific actions related to contaminated soils, groundwater or drinking water was identified in PL, EE, LV, or LT. However, no current or historical use of PFAS-foams was identified at local fire services or defense organizations in LT or LV. The knowledge and awareness varies within the region, and it is therefore necessary to transfer knowledge from countries that have come further in the process of developing national actions and in constructing dialogs between policy sectors and stakeholders.

Introduction

Per-and poly fluoroalkyl substances (PFAS) are a large group of man-made pollutants, lately receiving increased attention due to their global environmental distribution, extreme persistence in the environment, and potential risk to human health and ecosystems (OECD, 2013). PFAS have been produced since the 1950´s and are used in multiple consumer products and for industrial purposes due to their unique and useful properties, such as fat-, dirt- and water repellent, temperature resistant and film-forming (KEMI, 2015). Application areas for PFAS are e.g. as ingredients in fire-fighting foams, impregnation of clothing and textiles, paint, wax, insecticides, detergents and food packaging (EFSA 2011; Prevedouros et al. 2006). The Swedish Chemicals Agency (KEMI) estimated that there are 3000 available PFAS-substances on the global market (KEMI 2016). The most well-known substances are perfluorooctanesulfonate (PFOS) and perfluorooctanoic acid (PFOA) and their precursors, which have attracted scientific, regulatory and public attention during the last decade (Wang et al. 2017). PFOS and PFOA are of the so called long-chained type of PFAS, which are the ones mostly associated with toxic, bioaccumulative and persistent properties. Due to the increased concern of environmental and human adverse effects caused by PFOS and PFOA, they are gradually and voluntary substituted to shorter chains or non-fluorinated alternatives (Filipovic et al. 2013; OECD, 2013; Wang et al., 2015). However, these short-chained alternatives are of similar chemical nature and there are limited knowledge and information regarding their fate, exposure and adverse effects but existing evidence suggests a similar concern (Wang et al. 2017).

In 2007, the use of PFOS became restricted in the EU and the substance has been successively phased-out (Directive 2006/122/ECOF). Additionally, PFOS and its salts in 2009 became listed under the Stockholm Convention on Persistent Organic Pollutions (POPs), resulting in global restriction regarding the use and production (OECD, 2013). PFOS, is included in the list of priority substances (Directive 2013/39/EU) under the EU Water Framework Directive (2000/60/EG), implying obligated regular monitoring of surface water. PFOA and its salts are evaluated for potential listing under the Stockholm Convention on POPs and are currently listed as a Substance of Very High Concern (SVHC) at the European Chemical Regulation (REACH) (along with other PFAS such as PFHxS and PFDA). PFOS and PFOA are not regulated in the Drinking water Directive (98/83/EC) or the Groundwater Directive (2006/118/EC).

Scope of inventory

The inventory covers five thematic sections per country.

1. National strategies related to PFAS

PFAS-issues concern several different policy areas. This requires dialogue and coordination between several relevant stakeholders in order to increase knowledge and overcome problems. For example, communication between environmental authorities and fire and rescue services regarding the use of PFAS-containing firefighting foams. Coordination between policy areas may be required to develop national strategies e.g. to phase out the use of PFAS which could lead to environmental pollution, set target or limit values in drinking water and increase awareness among stakeholders.

Scope: National strategies, networks, awareness and discussions regarding PFAS. The questions were primarily addressed to members of the PA Hazards Steering Group, environmental agencies and known PFAS experts.

2. PFAS in firefighting foams

One of the main sources of environmental PFAS contamination is through the use of firefighting foams containing PFAS, generally used in large quantities directly on the ground or at sea. Firefighting foams containing PFAS are designed to extinguish fires of e.g. oil, diesel, plastics or alcohol (class B). Foams which may contain PFAS are aqueous film-forming foams (AFFF), alcohol-resistant aqueous film-forming foams (AR-AFFF), fluoroprotein foams (FP) and film forming fluoroprotein foams (FFFP). These foams are used in municipal fire-fighting departments, by the defense forces, at airports, petro-chemical industries, at oil platforms and on maritime vessels (OECD, 2013).

Firefighting foam is listed as acceptable propose for use and production of PFOS (and its salts) in the Stockholm convention[1]. Within the EU, fire-fighting foams containing PFOS are banned, however, foams placed on the market before 2006 could be used until 2011. Due to the ban of PFOS and industry voluntary phase-outs of long-chained substances, the new generation of fire-fighting foams (e.g. AFFFs) contains shorter-chains of PFAS (DK EPA, 2015). However, in many cases the information about the actual contents of the foams is considered confidential and they may contain other unintentional PFAS as impurities (KEMI, 2014; Wang et al. 2017). In a Swedish screening study, eighteen different PFAS were detected in surface water near fire training sites (Naturvårdsverket, 2016). In 190 of 214 investigated sites (89%), the Environmental Quality Standard[2] for PFOS was exceeded.

[1] Implemented in the EU through (EC) No 850/2004

[2] The EQS expressed as an annual average value (AA-EQS), EU Directive 2013/39/EU.

Several studies link the use of PFAS-foams to contamination of the environment. Case studies have detected high levels of PFAS (both longer and shorter alternatives) near both military and commercial airports (Ahrens et al. 2015; Filipovic et al. 2015). In case of accidents, environmental effects are secondary to rescuing life and PFAS-containing foam may be required for the fire-extinguish capability. However, during training of extinguishing fires (of the type class B) it is necessary to take into account the long-term environmental aspects when using firefighting foams containing PFAS, to prevent contamination of soil and leakage to surface- and groundwater nearby. In addition there are fluorine free foams available at the market.

Scope: The use of PFAS-containing firefighting foams during training, and knowledge and awareness about the potential environmental effects. The questions were primarily addressed to rescue services, defense forces and governmental organizations managing estates belonging to the defense sector, secondly to relevant authorities and ministries. In case of lack of response from the above, information was collected from environmental protection agencies.

3. PFAS-contaminated soil

Historical and current use of PFAS contributes to contaminated soils, which may act as sources for further spreading of PFAS to other matrixes of the environment, e.g. groundwater or surface water. A Swedish screening study found that an air force base, closed since the late 1980´s, still had high concentrations of PFOS and PFOA in the soil (Naturvårdsverket, 2016). Additionally, an airfield closed since approximately 20 years still leached PFAS from contaminated soil to groundwater nearby (Filipovic et al. 2015).

For contaminated soil, excavation and off-site disposal is the most commonly used remediation option. Accordingly to the Stockholm Convention, the concentration limit of PFOS in waste is 50 mg/kg. Landfill disposal of PFAS contaminated soil is in many cases not appropriate due to the high mobility of several PFAS (including PFOS and PFOA), which potentially can reach the environment through landfill leachate if the leachate is not treated properly. There is a need to develop more environmentally sound remediation techniques for PFAS contaminated soils, e.g. effective *in situ* methods.

Scope: National inventories of PFAS contaminated sites and executed and/or planned measures related to action plans and remediation. Questions were addressed to authorities handling contaminated soils and sites.

4. PFAS in groundwater and drinking water

The use and emissions of PFAS may eventually contaminate groundwater and surface water, potentially used as drinking water. Drinking water is believed to be one of the key human exposure pathways of PFAS (other important routes are via

food and dust) (D'Hollander et al. 2010). Exposure to PFAS may increase human health risks, such as affecting the thyroid gland, liver, fat metabolism and immune system. In 2013, a Swedish (Ronneby Municipality) drinking water station, supplied from groundwater, was closed because of PFAS contamination (concentrations up to 10,000 ng/L) (Jakobsson et al. 2014). PFAS contaminated drinking water was also revealed in Uppsala, Sweden in 2012. PFAS was detected in groundwater near point-sources, such as a close-by military air field, but also several kilometers downstream (up to 100 ng/L). Significantly higher concentrations of PFAS were detected in blood samples from young women who lived in districts exposed to contaminated drinking water compared to unaffected districts (Gyllenhammar et al. 2015).

Groundwater is remediated using pumping methods such as activated carbon filters or membranes on sites. This method can also be used to treat contaminated wastewater and landfill leachates. However, this method is considered energy intensive and limited efficiency of removing some short-chained PFAS (Wang et al. 2017).

Scope: Awareness, monitoring and actions related to contaminated groundwater and drinking water. Questions were addressed to geological and/or environmental authorities, health ministries or other agencies handling questions regarding drinking water quality.

5. Environmental PFAS-data

The large group of PFAS entails a variety of physicochemical properties, such as water solubility, volatilization, persistence and potential for bioaccumulation. PFAS are highly mobile and may transport in air and water, as well as in products across international borders. Consequently the substances may end up in different environmental matrixes such as: surface water, marine waters, groundwater, sediment, biota and air. In a Swedish screening study it was concluded that PFOS was most frequently found in biota, particularly in higher trophic levels (e.g. fish, mink, seal, otter), while "newer" substances such as 6:2 FTSA (common substitute for PFOS in firefighting foams) were most frequently found in water matrixes (Naturvårdsverket, 2016). Besides the use of PFAS in firefighting foams, waste water treatment plants (WWTPs) also play a significant role as sources for release of PFAS to surface water (Becker et al. 2008; Weinberg et al. 2011). Studies have shown that PFAS is not efficiently, if at all, removed in conventional WWTPs (Bossi et al. 2008).

In line with the WFD, PFOS shall be monitored in surface water according to established Environmental Quality Standards (EQS). EQS has been set for both biota and surface water. The EQS for biota is 9.1µg/kg DW and serves as protection for predatory consumption of fish (measured in muscle). The Annual Average-EQS for surface water is 0.65 and 0.13 ng/L for inland water and other surface waters, respectively. Maximum Acceptable Concentration-EQS of 36 µg/L

protect pelagic aquatic organisms (inland water) from acute toxic effects (for other surface waters the value is 7.2 µg/L). There are no EQS or limit values developed for other PFAS substances at EU-level. Additionally, PFOS is included as a HELCOM core indicator (requiring monitoring), which evaluate the status of marine environment based on concentrations in Baltic Sea fish.

Scope: Availability of environmental data (from monitoring, screening studies and research) from different environmental matrixes and WWTPs. Questions were addressed to authorities responsible for environmental monitoring and universities or agencies performing screening studies or other research.

Method

Relevant authorities, ministries and persons were identified in each EU-Baltic Sea Region country, i.e. Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Poland and Sweden. All authorities invited to participate are listed in appendix 1. The inventory was compiled based on questionnaires sent via email. The questions were of the type Yes/No/Don't know, followed by an option to comment answers (table 1). Additionally, there were some general questions related to overarching national policies or strategies. Some questions (and any follow-up questions) were submitted directly via email correspondence. The questionnaires were sent out during April 2017 and responses received until end of May 2017.

In April 2017, the Swedish Chemical Agency held a Nordic PFAS-workshop. Sweden, Germany, Denmark and Finland participated in the workshop. The participants were asked to respond to a questionnaire regarding PFAS-related issues (national action plans, upcoming activities etc.). Some of the answers received in the Nordic PFAS-workshop (questions underlined in table 1) has been used in this inventory and equivalent inquiries were sent to the other BSR countries (Estonia, Latvia, Lithuania and Poland) to complement the answers. National Implementations Plans (NIPs) according to the Stockholm Convention, national reports and web searches have also been used to collect additional national information regarding PFAS.

The open scientific literature (Scopus and Web of Science) was used to search for previous research in each country. The following key-words were used: PFAS, PFOS, PFOA, PFC, Per-and poly fluoroalkyl substances *environmental analysis, environmental measurements, environmental monitoring, WWTP, air, biota, sediment, groundwater, drinking water* Poland, Estonia, Lithuania, Latvia, Germany, Denmark, Finland, Sweden.

Table 1. Questions in the questionnaires sent to all EU-BSR countries for the inventory of awareness, actions and national strategies of PFAS in the Baltic Sea Region. Questions posed by the Swedish Chemical Agency to competent authorities in Sweden, Germany, Denmark and Finland (April 2017, se text for more information) are underlined.

National strategies related to PFAS	1. Does your country have a national action plan for PFAS? 2. Does your country have a national network (for knowledge exchange and cooperation) regarding PFAS-issues? 3. Is there an ongoing discussion about environmental issues coupled to PFAS in fire-fighting foams in your country? 4. Has potentially sources of PFAS been identified in your country? 5. Are there any ongoing/upcoming activities in your country such as regulation, monitoring, research etc.? 6. Has your country identified any environmental and/or health risks related to PFAS? 7. What do you consider being the biggest issues related to PFAS?
Firefighting foams	1. What type of foams does your organization use? 2. Is your organization aware of the environmental issues coupled to the use of fire-fighting foams containing PFAS? 3. Are there any restrictions and/or recommendations (actions to minimize the spread of PFAS in the environment) when using fire-fighting foams containing PFAS during training? 4. Is there an ongoing discussion (at your organization or in your country in general) about any restrictions and/or measures when using fire-fighting foams containing PFAS?
Contaminated soil	1. Has your country inventoried PFAS-contaminated soils? 2. Does your country have an action plan or strategy for PFAS-contaminated soil? 3. Has your country at any time conducted a remediation of a PFAS-contaminated soil?
Contaminated groundwater	1. Has your country inventoried PFAS-contaminated groundwater? 2. Has your country at any time detected PFAS in groundwater? 3. Does your country monitor PFAS in groundwater on a regular basis? 4. Are there available measurements of PFAS in groundwater from screening studies and/or research or other projects? 5. Has your county established threshold values for PFAS in groundwater?

Contaminated drinking water	1. Has your country at any time detected PFAS in drinking water? 2. Is there regular monitoring of PFAS in drinking water? 3. Has your country established indicative threshold values for PFAS in drinking water? 4. Does your country monitor PFAS in waters bodies used as source of drinking water? 5. Has your country estimated how many people may be/have been exposed to PFAS through drinking water?
Environmental data	1. Is PFOS included in regular environmental monitoring? 2. Are other PFAS included in regular environmental monitoring? 3. Are there available measurements of PFAS from screening studies and/or research or other projects? 4. Has your country established threshold values (e.g. EQS) for any PFAS other than PFOS? 5. Has the AA-EQS (surface water) for PFOS (of 0.65 ng/L given in WFD) been exceeded in your country at any time? 6. Has the AA-EQS (biota) for PFOS (of 9,1 µg/kg given in WFD) been exceeded in your country at any time?

Results

The results of this inventory are based on incoming responses to the provided questionnaires and personal communication including follow-up questions (Appendix 1 and 2), information found in the Stockholm Convention National Implementation Plans, and information provided in national reports. The summary below is based on the information provided by each country. All unedited responses are presented in detail in Appendix 2. In addition, all respondents were invited to review and comment a draft version of the text. References to reports and results are given in footnotes (except for scientific literature).

Regional activities

The 3rd European Conference of Defense and the Environment (ECDE) was recently held in Helsinki (31 May – 2 June, 2017)[3]. The conference had a whole session dedicated to the emerging issue of PFAS-contamination linked to the use of firefighting foams containing PFAS within the military[4]. During this conference Finland, Germany, France and Norway presented their national work associated with PFAS contaminated sites. According to the Swedish Fortifications Agency and the Defense Command Finland, PFAS-related issues have also been raised within the Nordic-Baltic Defense Estates (NBDE), a cooperation forum for governmental organizations which manage real estate's belonging to the defense sector. However, there is no public information available about the content or results of such discussions.

HELCOM is publishing a State of the Baltic Sea assessment in 2018. First results will be available by mid-2017. PFOS is included as a core indicator in the assessment.

Between 2009-2012, the PA Hazards flagship project Control of Hazardous Substances in Baltic Sea (COHIBA), including all Baltic Sea countries except Russia, conducted analyses of PFOS, PFOA, PFHxA and PFDA in landfill leachates, storm waters, WWTP effluents (municipal and industrial) and sludge. General results for all countries were: in storm water, municipal and industrial effluents, PFOA was most frequently detected, but PFOS was detected in highest concentrations. In landfill leachates, PFOA was most frequently detected, but the highest concentrations were detected for PFHxA. In sludge PFOS and PFDA were the most detected substances (found in all samples), with highest concentrations of PFOS.[5] A current PA Hazards flagship project, NonHazCity[6], aims to reduce

[3] The conference was organized by the Finnish defense administration and supported by DEFNET, an informal, expert-level, group comprising mainly of environmental focal-points and specialists from the Ministries of Defense of EU Member States, and Nordic-Baltic Defense Estates, which is a cooperation forum for building and construction organizations of defense administrations in the Nordic and Baltic countries.

[4] http://www.ecde.info/speakers/and-polyfluoroalkyl-substances-pfas

[5] How to control and manage hazardous substances in the Baltic Sea region, Final summary report of the COHIBA project (2012). https://www.lung.mv-regierung.de/dateien/a3_cohiba_final_summary_report_2012.pdf

emissions of hazardous substances, including PFAS, from urban areas within the Baltic Sea Region (2016-2019). PFAS are going to be analyzed in sewage.

In 2004, a Nordic regional screening for PFOS, PFOA, PFHxA, PFHpA, PFNA, PFHxS, PFDS and PFOSA in surface water, marine water, sediment, WWTPs, sludge, fish (marine and freshwater species), marine mammals and marine birds was performed. PFOS and PFOA were found in nearly all samples.[7] A new Nordic screening study of PFAS and total organic fluorine (TOF) in selected environmental samples is planned for 2017. [8]

Sweden

National strategies and actions

In 2014, after the discovery of PFAS-contaminated drinking water in several municipalities, the Swedish Chemical Agency (KEMI) and the National Food Agency jointly initiated a national PFAS-network. The network includes national authorities, research institutions, municipalities, water producers and other relevant stakeholders, and the aim is to increase and share knowledge on a national level. In parallel a network for national authorities[9] was formed with the main aim to coordinate responsibilities. KEMI has developed a strategy to reduce the use of PFAS, and minimise and eventually stop uses of PFAS which could lead to environmental pollution.[10] The Swedish government has commissioned KEMI to develop a cross-cutting action plan for initiatives on a national, EU and international level. In 2016, the Swedish Environmental Protection Agency (SEPA) did a screening for the presence of PFAS in the environment. In total, about 6,000 measurements were compiled (former and new measurements between the years 2000-2016) and 2,000 potential point sources were identified, including firefighting training sites, WWTPs and waste treatment facilities[11]. The study concluded that PFAS are widespread in the Swedish environment and that humans and the environment risk exposure to PFAS at levels that may cause adverse effects. A follow-up study was commissioned by the Government to continue the inventory and to do risk assessments of all sites where firefighting foams have been used.

Several drinking water supplies have been closed in Sweden during the past years due to PFAS-contamination. Health surveys of the most affected communities are currently ongoing, but there are no results yet. In addition, it was decided in 2011

---

[6] www.nonhazcity.eu

[7] http://nordicscreening.org/index.php?module=Pagesetter&type=file&func=get&tid=5&fid=reportfile&pid=5

[8] http://www.nordicscreening.org/

[9] Swedish Chemical Agency, National Food Agency, Swedish Environmental Protection Agency, Swedish Agency for Marine and Water Management, Geological Survey of Sweden, Swedish Geotechnical Institute, Swedish Civil Contingencies Agency, Surgeon General and Swedish County Board.

[10] http://www.kemi.se/global/rapporter/2016/report-11-16-strategy-for-reducing-the-use-of-higly-fluorinated-substances-pfas.pdf

[11] http://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6709-0.pdf?pid=17835

that fish from lakes affected by contamination from Malmö Airport should not be consumed.

Firefighting foams

The Swedish Civil Contingencies Agency (MSB)[12] and Surgeon General[13], are members of the Swedish national PFAS-networks. MSB is responsible for the education of fire and rescue services and work towards minimizing the use of firefighting foams to occasions when it is the only effective method.

The Swedish Armed Forces is yearly publishing environmental reports including issues related to PFAS[14]. Lately, PFAS has been prioritized and the Swedish Armed Forces and the Swedish Fortifications Agency has conducted surveys to investigate sites and environmental risks where firefighting foams have been used.[15]

KEMI, SEPA and MSB have produced a brochure with recommendations to only use PFAS-containing foams when no other alternative extinguishing methods are applicable, and to collect and send extinguishing water and residues of firefighting foams for destruction (foams should be handled as hazardous waste).[16] KEMI has proposed national regulation of collection and destruction of PFAS-containing foams associated with firefighting training.

Contaminated soil

On a national level, PFAS-contaminated soil has been partly inventoried as a result of the SEPA screening study in 2016, and sites where firefighting foams have been used will be extensively inventoried by 2018 in the follow-up assignment (see above).

Guideline values have been established by the Swedish Geotechnical Institute, (SGI) for sensitive soils (e.g. at sites used for building houses) and less sensitive soil (e.g. industrial land) of 0.003 and 0.020 mg PFOS/kg dry weight, respectively. The guideline values are designed to facilitate risk assessments, to provide a basis for decisions on actions and to prioritize between different contaminated sites

According to SEPA, no government funded excavations of PFAS-contaminated soils have been done. However, SEPA has no information regarding possible

[12] Compent agency for developing the society´s ability to prevent and handle accidents and crises

[13] Responsible for control of activities within the Swedish armed forces with regards to environmental and health protection

[14] http://www.forsvarsmakten.se/siteassets/4-om-myndigheten/vart-arbetssatt/vart-miljoarbete/fm-miljoredovisning-2015-1.pdf

[15] http://www.kemi.se/global/rapporter/2016/rapport-1-16-forslag-till-nationella-regler-for-hogfluorerade-amnen-i-brandslackningsskum.pdf

[16] http://www.kemi.se/global/broschyrer/rekommendationer-for-brandskum.pdf

excavations during exploitation and development by private actors. The Geological Survey of Sweden (SGU) and SGI are developing and testing new techniques and methods for *in situ* remediation. SEPA and SGI are currently working with a guidance document regarding management of PFAS contaminated sites.

Groundwater and drinking water

In the national monitoring programme for groundwater, PFAS are not included. However, according to SGU, if PFAS are detected at a site included in the national sampling programme, e.g. in a screening campaign or research study, they will be analyzed continuously. Groundwater was inventoried for PFAS-contamination within the SEPA screening study in 2016. Measurements from close to 500 sites showed that up to 80% of all groundwater samples collected close to a firefighting training site were contaminated (average concentration PFAS-7 was 43,927 ng/L). In areas with no known point source, ca 40% of the groundwater samples contained PFAS. A preliminary threshold value for PFOS of 45 ng/L has been established for the protection of groundwater as a natural resource and a potential resource for drinking water. Currently, the Swedish Water Authorities have proposed an EQS for the summary of 11 PFAS in groundwater which will be established in 2018.

Water producers are responsible for controlling the quality of drinking water. Due to the discovery of PFAS in drinking water in the recent years, some water producers and the Swedish Water and Wastewater Association (SWWA) have conducted several measurements. There are no legal limits of PFAS concentrations in drinking water. However, the Swedish Food Agency has established an action level for the sum of 11 PFAS[17] to 90 ng/L in drinking water, i.e. the water producer need to take immediate action to reduce the concentrations. At concentrations above 900 ng/L the water should not be consumed at all. In Sweden, 35% of all drinking water sources have been analyzed for PFAS. It is estimated that ca. 300,000 persons have been exposed to PFAS-levels above 90 ng/L in their drinking water. No analyzes have been made in private drinking water wells.

Pump- and treat methods (e.g. active carbon filter) have been used to remediate contaminated groundwater and drinking water (information from SEPA).

Environmental data

The Swedish national environmental monitoring programme includes 15 PFAS-[18] monitored in freshwater[19] and marine[20] biota. PFOA and PFOS are regularly monitored in air and atmospheric deposition. In 2017, the monitoring of air will be

[17] 6:2 FTSA, PFBS, PFNA, PFDA PFBA, PFHxS, PFOS, PFPeA, PFHxA, PFHpA, PFOA

[18] PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFPeDA, PFBS, PFHxS, PFOS, PFDS and FOSA

[19] http://www.diva-portal.org/smash/get/diva2:1090766/FULLTEXT01.pdf

[20] http://naturvardsverket.diva-portal.org/smash/get/diva2:1091353/FULLTEXT01.pdf

extended to include 14 PFAS substances. In addition, PFAS are monitored in sludge and sewage water.

According to the Water Authorities, measurements of PFOS in surface water are carried out by certain county administrative boards (but no systematic monitoring program) and several water bodies have been status classified based on AA-EQS for surface water. Surface water and sediment has been included in screening studies several times.[21,22] The 2016 SEPA screening study showed that PFAS was detectable in 98% of the surface water samples. In all samples where PFOS was detected (40%), the AA-EQS was exceeded. The EQS for biota has also been exceeded in several measurements, mainly close to firefighting training sites but also in areas lacking known point sources. Different projects on trend monitoring and screening studies (e.g. total organic fluor) and monitoring (not yearly) are on-going and increased national monitoring is planned by SEPA.

Several research projects available in the scientific literature report presence of PFAS in the Swedish environment.

Denmark

National strategies and actions

PFOA and PFOS are included in the Danish EPA List of Undesirable Substances (LOUS)[23] and have been subject to a LOUS-review to provide basis for an assessment of whether there is a need for further information, regulation and/or other risk reduction measures.[24] An action plan for the reduction of PFOS in Denmark has been developed, and is included in the updated Danish national implementation plan for the Stockholm Convention in 2012.

The following initiatives are listed in the NIP from year 2013.

1. Study on the use of PFOS in Denmark
2. Notification of acceptable uses
3. Communication to users of PFOS for acceptable uses in Denmark
4. Examination of PFOS / PFOA as soil and groundwater contamination
5. Assessment of the presence of PFOS in household waste
6. Validation of destruction of PFOS
7. Any requirements for the disposal of PFOS-containing household waste

The large group of individual substances and the lack of information about health effects are considered key issues related to PFAS. In recent years, the Danish EPA has launched a number of initiatives to increase the knowledge about PFAS. For example, health and environmental effects of short-chained PFAS [25], an inventory

[21] http://naturvardsverket.diva-portal.org/smash/get/diva2:736466/FULLTEXT01.pdf
[22] http://naturvardsverket.diva-portal.org/smash/get/diva2:657980/FULLTEXT01.pdf
[23] http://www.mst.dk/English/Chemicals/assessment_of_chemicals/lous_list_undesirable_substances_2009/

[24] http://www2.mst.dk/Udgiv/publications/2013/04/978-87-93026-03-2.pdf
[25] http://www2.mst.dk/Udgiv/publications/2015/05/978-87-93352-15-5.pdf

of industry sectors where PFAS are used[26], a review of knowledge about PFAS contamination in groundwater[27] and a study on alternatives to PFAS in textiles[28].

Specific attention has been given to the presence of PFAS in food and in materials coming into contact with food. The Danish Veterinary and Food Administration discourage the use of all fluorinated organic substances in paper and board food contact materials.

Firefighting foams

The Danish Emergency Management Agency (DEMA) is aware of the environmental issues coupled to the use of firefighting foams containing PFAS. The main attention has been focused on PFOS and PFOA and there is limited knowledge about the presence of alternative PFAS in foams is currently used by local fire and rescue services and at airports. AFFF are supposedly not used by DEMA's national fire and rescue centers. However, they have no knowledge about the use of AFFF within the municipal fire and rescue services and are therefore considering doing a survey. A centralized procurement of foams would enable control of the use of AFFF. Due to limited knowledge there is currently no national discussion about measures or guidelines on how to prevent environmental risks using AFFF and it is not an issue high on the agenda.

According to the Danish Defence Estates and Infrastructure Organisation (EIO), the current use of PFAS foams within the Danish Armed forces is under investigation. The EIO has conducted investigations of 21 PFAS contaminated sites.

During this inventory, no national restrictions or recommendations regarding the use of foams during training have been identified.

Contaminated soil

Systematic mapping of PFAS contaminated soil has been required since 2015 (the regions are responsible for inventory and possibly remediating). The same year a threshold value for soil of 0.4 mg/kg was established for the summary of 12 PFAS[29]. Danish Regions are currently developing guidelines on how to conduct investigations on PFAS contaminated soil. One remediation (pump and treatment by carbon filter) of PFAS-contaminated soil has been conducted at Copenhagen airport, but not at any sites administered by the Danish Defense. It is not known by the Danish Regions if any privately funded remediation has been conducted.

[26] http://www2.mst.dk/Udgiv/publikationer/2016/12/978-87-93529-43-4.pdf

[27] http://www2.mst.dk/Udgiv/publikationer/2016/11/978-87-93529-29-8.pdf

[28] http://www2.mst.dk/Udgiv/publications/2015/05/978-87-93352-16-2.pdf

[29] PFBS, PFHxS, PFOS, PFOSA, 6:2 FTS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA and PFDA

Groundwater and drinking water

At sites with known PFAS-contamination or risk for contamination, raw water and drinking water are controlled for PFAS according to the Drinking Water Decree from 2015. The Danish EPA has established an administrative quality criterion for groundwater and drinking water of 100 ng/L for the sum of 12 PFAS (same substances as for contaminated soil), which are regularly monitored in groundwater used for drinking water. PFAS has been detected in groundwater but the criterion was not exceeded in any samples analyzed and collected between 2013 and 2016 (highest measurement was 55.7 ng/L)[30].

No measures regarding contaminated groundwater have been taken (e.g. remediation or closing of water stations), according to the EPA. Letters have been sent to local authorities informing that there is a risk for possible groundwater contamination close to fire extinction sites.

Denmark did a screening of contaminated soil and groundwater associated with point sources in 2014. It was concluded that there is a risk for PFAS contamination of groundwater at firefighting sites and that PFAS was found at all the well-studied sites, concentrations ranging from a few to several thousand ng/l. In 2016, the Danish EPA carried out a screening aiming to analyse the total organic fluorine in groundwater[31].

Environmental data

PFOS, PFOA, PFNA, PFOSA, PFDA, PFHxS have been monitored in surface water, sediment and marine biota (2009-2016).[32] Between the years 2017-2021 the substances are going to be monitored in biota from rivers, lakes and marine waters and in WWTP (inlet and outlet). Additionally, 12 PFAS (same as mention regarding contaminated soil) will be included in regular monitoring in groundwater. AA-EQS for both surface water (monitored 2010-2016) and biota have been exceeded. Denmark has previously conducted screening studies for PFAS in different aquatic matrixes including groundwater[33,34], landfill leachates and waste water.

Scientific literature studies analyzed harbor seals (*Phoca vitulina*) and harbor porpoise (*Phocoena phocoena*) for PFOS, PFHxS, PFDA, PFNA, PFUnA, PFOA and PFOSA (Dietz et al. 2012; Galatius et al. 2011). Bossi et al. (2008) investigated samples from WWTPs (inlet and outlet), sediment, sludge and biota (same substances as mention above).

[30] http://www.geus.dk/DK/water-soil/monitoring/groundwater-monitoring/Documents/g-o-2015.pdf
[31] http://mst.dk/virksomhed-myndighed/kemikalier/fokus-paa-saerlige-stoffer/listen-over-uoenskede-stoffer/status-for-lous/9-pfas/
[32] http://dce2.au.dk/pub/SR142.pdf
[33] http://www.dmu.dk/Pub/FR608.pdf
[34] http://www2.mst.dk/Udgiv/publikationer/2014/10/978-87-93178-96-0.pdf

According to the Danish Veterinary and Food Administration, PFOS and PFOA are monitored in foods of animal and plant origin since 2011.

Germany

National strategies and actions

According to information from the Nordic PFAS-Workshop, Germany does not have a national action plan for PFAS. The biggest concern related to PFAS is the use and presence of short-chained PFAS in the environment. Short-chained PFAS are persistent and mobile and may enter raw water, drinking water and food. To date, there is no effective removal technology available.

Several projects are ongoing or planned within the next few years, regarding research and restriction proposals (e.g. for for C9-14 PFCAs). In Germany limit value for PFOS and PFOA in sewage sludge for agricultural recovery is 100µg/kg. Retrospective testing for PFOS and other PFAS of archived material in the Specimen Bank is ongoing.[35]

Firefighting foams

According to the German Environment Agency (UBA) there is no national restriction of the use of AFFFs. A number of cases are known where soil, groundwater, and surface water have been contaminated subsequently to the use of AFFFs. Areas include e.g. airports, where AFFFs have been used for training purposes or, as in the case of the Düsseldorf airport, due to a plane crash. Based on an assessment of the North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection the (former) use of firefighting foams produced approximately 50% of the known PFAS-polluted sites in North-Rhine Westphalia.

A guideline for environmentally responsible use of PFAS-foams has been published by UBA.[36] Some of the Federal States have developed threshold values for PFAS, which means that fire extinguishing water has to be collected (if possible), analyzed regarding the PFAS content and properly disposed of. It is not known if this is the case for all 16 States.

A register of all known PFAS contaminates sites or an area of suspected contamination (e.g. those areas where AFFF was used to extinguish fires in the past) does not exist in Germany. The Federal Ministry of Defense (MOD) has investigated all Federal Defense sites to identify potential PFAS risks, the work is performed under the MOD Contaminated Sites Remediation Program. 74 sites have been identified as contaminated or suspected to be contaminated. An action guideline for managing PFAS-contamination has been published in 2015.

[35] https://www.umweltprobenbank.de/en/documents/profiles/analytes/14121

[36] http://www.umweltbundesamt.de/publikationen/guide-environmentally-responsible-use-of

[37]Additionally, the use of AFFF during training at Federal Defense fire brigades is only allowed when performed within closed systems.

Contaminated soil

According to the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB), Germany has inventoried PFAS-contaminated soils to some degree (under state responsibility). Regarding action plans and strategies for soils there is currently no coordinated approach. Guideline papers are available focusing on identification of contaminated sites.

In 2006 the first German PFAS contamination became evident, caused by illegal intermixing of PFAS containing sludge into soil conditioner to agriculture sites (Skutlarek et al 2006). In a recent case in South Germany, agricultural fields have been contaminated predominantly with short chain PFAS. Most probably, sludge from paper industry had been mixed with compost and applied to the fields. Short chain PFAS are leaching to underlying groundwater and are partly taken up by plants and fruits. Since then, authorities have become more aware of PFAS-issues, but more efforts are needed to deal with these issues according to BMUB.

In terms of remediation, Germany has removed soil and conducted thermal treatment (landfills and active carbon filters). However, there is a need to develop more effective methods *in situ* (according to BMUB). Therefore, within the time frame from 20017-2020 a research project of the German Environment Agency will be launched to evaluate the technical feasibility and proportionality of remediation approaches of PFAS contaminated soils. The goal is to develop a code of practice and management concepts of PFAS contaminated areas for the local authorities.

Groundwater and drinking water

According to UBA, PFAS contaminated groundwater has been inventoried and several of substances have been detected. There is no regular monitoring of PFAS in groundwater or drinking water and measures taken are varying between the Federal States, with some states conducting investigations of drinking water.[38] According to the Department of Waters, Division of Groundwater Hydrology and Groundwater Protection (at the State Agency for Agriculture, Environment and Rural Areas of the German Federal State Schleswig-Holstein), there is no regular monitoring of PFAS in groundwater, chemical tests take place occasion-related (in the state Schleswig-Holstein). According to UBA, there are no available measurements for Mecklenburg-Vorpommern.

[37] http://www.arbeitshilfen-bogws.de/downloads/Leitfaden%20PFC.pdf

[38]https://www.lgl.bayern.de/lebensmittel/warengruppen/wc_59_trinkwasser/ue_2009_trinkwasser_pft.htm

Twelve PFAS were detected in drinking water in the state North Rhine-Westphalia with maximum concentrations of 598 ng/L, most dominant of PFOA (510 ng/L) in a research project (Skutlarek et al. 2006). In the recent case in Southern Germany short-chain PFAS were monitored in elevated concentrations in groundwater and some drinking water wells. Efforts are carried out to purify the water from PFAS in this area.

Germany has derived guidance values (health-based orientations values) for all PFAS that has been found in German groundwater applied for both groundwater and drinking water. The guidance values are individual for substances varying from 60ng/L (PFDA) to 10,000 ng/L (PFBA).

Environmental data

According to the German Oberflächengewässerverordnung (OGewV), implementing the WFD, PFOS has to be monitored in biota (fish) and surface water, in transitional and coastal waters from 2018. Nevertheless, PFOS (as well as other PFAS) have been monitored by several Federal States in surface waters in previous years. Some Federal States have also already started to monitor PFOS and other PFAS in biota. According to UBA, not all monitoring data are publicly available.

In a national monitoring program (2017-2019) for urban waste water treatment plants, 49 treatment plants of different size will be sampled monthly for a one year period. Among other WFD priority substances, PFOS is included as parameter.

In the scientific literature a study using a method of adsorbable organically bound fluorine (AOF) analyzing samples from rivers, WWTPs and groundwater from firefighting training sites was found (Willach et al. 2016). Other available literature investigates PFAS in landfill leachates, sediment, air and in freshwater, marine and terrestrial biota (Buch et al., 2010; Zhao et al. 2015; Jahnke et al. 2007; Dreyer et al. 2015; Schuetze et al. 2010; Ahrens et al. 2009; Rüdel et al. 2011).

Finland

National strategies and actions

Finland has a national network including ministries, agencies, researchers and the Finnish defense force, yearly discussing PFAS issues. The Finnish Environmental Institute (SYKE) considers the contamination of water resources and the historical use of AFFFs as the key PFAS-issues. Sites with potential contamination have been inventoried and some of them identified, mainly focusing on fire training sites. However, the extent of the contamination in the whole country has not been fully assessed, nor the related risk. The general discussion regarding fire-fighting foams are mainly professional (within the network and others of concern) and have not reached public awareness (public concerns are generally about PFAS in consumers products).

National actions related to PFOS in the NIP from 2012, addresses following action:

1. Determine whether the use of PFOS is consistent with the Stockholm Convention agreements
2. Minimize emissions of PFOS
3. Promote the introduction of PFOS replacements
4. Implement measures recommended by the Stockholm Convention
5. Investigate PFOS contaminated sites (soil and groundwater)
6. Implement actions to reduce risk of areas were PFOS in firefighting foams has been uses.

Firefighting foams

However, the Defense Command Finland and is aware of issues related to PFAS and environmental inventories and investigations have been made. According to the Finnish Defense, the military aviation firefighting crews use AFFFs during accidents (not during training). The use of foams is prohibited at fire training areas of airports (areas used by the military aviation fire crews). Currently, a detailed inventory of firefighting foams is carried out including screening of present and former use of foams (conducted by SYKE). The Finnish aviation company Finavia has stopped using foams when training on their airports since 2012 (now days only using water) (information from SYKE). SYKE did not know the status of other Finnish operation regarding restrictions and recommendations when using foams. The ministry of the Interior (Department for Rescue Services) is not aware of discussions of PFAS-issues coupled to fire-fighting foams (the use of foams is considered minor) and there are no current restrictions or recommendations (other than EU legislation).

Contaminated soil

Finland does not have a specific strategy for PFAS contaminated soil, but actions aiming to identify and investigate the risk of sites. SYKE was aware of one conducted remediation were the soil was excavated and disposed (the POPs limit value of 50 mg/kg was not exceeded). However, since there is no consensus of acceptable risks regarding soil or groundwater, PFAS-contaminated soil has not systematically been remediated.

Groundwater and Drinking water

PFAS have been detected in both groundwater and drinking water. In groundwater near fire training sites 18 out of 23 PFAS were detected and most frequently found were PFOS, PFHxS, PFOSA and 6:2 FTSA. In raw water 10 out of 18 PFAS were detected and at least one compound detected in 40% of the samples (LOQ = 0.1 – 0.5 ng/L) (screening form 2015-2016, report not published yet).

Specific actions regarding contaminated raw water have not been taken, because the concentrations were very low compared to the limits for drinking water in other

countries. Further measurements of groundwater and contaminated sites are on-going (SYKE project: PFARA) and risks caused by landfills are going to be addressed. For risk management purposes the Ministry of social affairs and health has gathered information on threshold values of PFOS in drinking water from different EU member states. Additionally, national EQS for groundwater are being considered.

Environmental data

According to SYKE, 17 PFAS[39] are included in regular biota monitoring.[40,41] PFAS are occasionally monitored in freshwater, e.g. during 2016-2017 21 PFAS are being monitored in 11 rivers with 8 monthly samples. In addition, there are available screening studies for PFAS in effluents and sludge from WWTPs, soil and earthworm.[42,43,44] Both AA-EQS for surface water and biota has been exceeded for PFOS. 7 PFAS[45] was detected in both Finnish Baltic Sea and freshwater fish in a research project. The concentrations of PFOS in fish muscle were 4-fold above the AA-QS (Koponen et al. 2015). Further monitoring studies are going to be carried out at high-risk sites (e.g. fire fighting training sites)

Poland

National strategies related to PFAS

During the inventory, no ongoing discussions regarding PFAS contaminations at the national level were identified. There were no specific PFOS related measures in the NIP from 2016. General actions addressed for POPs were e.g. inventories of POPs emission into air, water and soil; Identification of the impact of POPs on human health and environment and monitoring of the current status of the national environmental pollution. From the incoming responses it has been assessed that, , other than general concerns of PFOS and PFAS, there seems to be a lack of identification of possible environmental and health risks of PFAS. Collected information from several relevant stakeholders was fragmented and lacked a clear overview.

Firefighting foams

The Ministry of Economic Development is aware of environmental issues related to firefighting-foams, mainly with regards to PFOS. There are no further recommendations or restrictions of the use other than EU legalization. According

[39] PFOS, PFOA, PFHxA, PFPA, PFNA, PFDA, PFUnA, PFDoA, PFTrA, PFTA, PFHpS, PFHxS, PFDS, PFOSA, Et-PFOSA, 4:6 FTS and 8:2 FTS

[40] http://tietokayttoon.fi/documents/10616/2009122/Kaukokulkeutuvat+ymp%C3%A4rist%C3%B6myrkyt+Suomen+pohjoisilla+alueilla+%E2%80%93+LAPCON/f76a683e-abe6-47bf-aada-48d2b38c5ef7?version=1.0

[41] http://hdl.handle.net/10138/166296

[42] https://www.vvy.fi/vesihuolto_linkit_lainsaadanto/jatevedet/haitalliset_aineet_-hanke_2013

[43] http://www.vhvsy.fi/files/upload_pdf/5004/Julkaisu%2073_2015.pdf

[44] http://hdl.handle.net/10138/169282

[45] PFOS, PFOA, PFNA, PFDA, PFUnA, PFDoA; PFTrA

to the department of Industrial Regulation (Ministry of Development) the following foams are used within the country: AFFFs, FPs and the fluorine free type STHAMEC F-15. The State Fire Service use AFFFs, FPs and limited amount of FFFPs.

Contaminated soil

There are no known activities or inventories related to PFAS contaminated soil according to the Ministry of the Environment and the Department of Agriculture and Environmental Protection.

Groundwater and Drinking water

Measurements of PFAS in groundwater are not available according to the Chief Inspectorate of Environmental Protection, the National Institute of Public Health and the Ministry of the Environment. The Department of Water Health Safety has no documentation regarding PFAS in drinking water. According to the Environmental Hygiene Department, problems related to PFAS have not been adequately studied in Poland. Polish tap water and bottled mineral water has been investigated for 12 PFAS substances in a research pilot-project (tap water samples from Gdańsk University). Tap water showed higher degree of contamination (concentrations up to approximately 1-1,2 ng/L) compared to bottled water (Rostkowski et al. 2008). However, it is not known if the drinking water originated from sites near potentially sources or not.

Environmental data

In 2014, the first yearly biota monitoring of PFOS (muscles of flounder, herring, and perch) was carried out in the Polish marine areas of the Baltic. Two reports on the marine areas have been published and the publication of 2016 is under preparation[46]. The monitoring of PFOS in biota matrix in inland waters started in 2016. According to Chief Inspectorate of Environmental Protection EQS for biota has been exceeded in five monitoring stations located on rivers and in one monitoring station located on lakes out of 197 monitoring stations on inland waters examined so far. PFOS was monitored in sediment during 2016. The results ranged from <0,01 mg/kg to 0,056 mg/kg of PFOS concentration in sediments of analysed samples (at six locations). During 2017 a project aiming to monitor PFOS in biota and sediments is going to be carried out (information provided from to Chief Inspectorate of Environmental Protection). Several PFAS research projects have been published in the scientific literature including data of surface water, drinking water, biota and sediment. Surface water (rivers , lakes, streams and coasts) was analyzed for 12 PFAS[47], with PFOS being detected at most of the sites with concentrations up to 150 ng/L. High concentrations were also detected for PFHxS and PFOA of 110 and 18 ng/L, respectively (Rostkowski et al. 2009). White-tailed

[46] http://www.gios.gov.pl/images/dokumenty/pms/monitoring_wod/Ocena_stanu_2015.pdf

[47] PFOS, PFHxS, PFBS, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFTeDA, PFHxDA and PFOcDA

Sea Eagles (*Haliaeetus albicilla*) liver samples collected from the Polish coast (and eastern Germany) between 1979-1999, where analyzed for PFASs. PFOS was detected in nearly all samples (<3,9-127 ng/g ww) while FOSA, PFHxA and PFOA were not detected (Kannan et al. 2002). PFOS, PFOA and PFDA were present in all European Beaver's (*Castor fiber*) liver samples (PFOS ranging from 1,6-39 ng/g ww) as well as in whole blood of Cod (*Gadus morhua*), Velvet Scoter (*Melanitta fusca*), Eider Duck (*Sommateria mollisima*), Long-tailed Duck (*Clangula hyemalis*), Razorbill (*Alca torda*) and Red-throated Diver (*Gavia stellata*). Other substances measured were detected at lower concentrations and less frequent (Falandysz et al. 2007). A more recently study also detected PFOA (all samples), PFOS (highest concentrations) and PFNA in European beaver (*Castor fiber* L.) (Surma et al. 2015). Samples of surface sediment and sediment core from the Gulf of Gdansk was determined for 9 PFAS [48] (Limit of quantification LOQ 2 pg/g) (Falandysz et al. 2012). In general, there is good access to public research investigating PFASs in human blood serum.

Lithuania

National strategies related to PFAS

In Lithuania, the lack of data on sources and concentrations in groundwater and drinking water are considered as key issues related to PFAS (according to the EPA and National Public Health and Geologists). Yet, environmental and health risks have not been identified. Some discussion regarding environmental issues coupled to the use of PFAS-foams are going on, including a workshop with firefighters accomplished by the EPA. There are currently no specific national actions regarding PFAS. Potential sources of PFAS have been inventoried in wastewater and sludge of different economic entities.

Firefighting foams

The Fire and Rescue Department use foams in cases when water is ineffective. However, they stated that only fluorine free foams (STHAMEX F-15 and Fomtec MB-20) are used when extinguishing fires of Class B. After major accidents they contact regional environmental agencies. According to the Fire and Rescue Department, they are aware of environmental issues caused by PFAS. Although, no current use of PFAS-foams are known there are general recommendations to use less foams (fewer occasions).

In addition, the Ministry of Defense does not use foams containing PFAS (and there are no records of previous use) instead they are using water and fluorine free foams. For this inventory, there has been no information regarding the use of PFAS-foams at airoports or at local municipalities.

[48] PFOS, PFHxS, PFDA, PFNA, PFOA, PFHpA, PFUnDA, PFDoDA and PFHxA

Contaminated soil

Lithuania has not inventoried PFAS-contaminated soils or at any time conducted a remediation. According to the Lithuanian Geological Survey, the implementation of the NIP 2017-2025" (when approved by the Minister of the environment) will include inventories of PFOS-contaminated sites (soil and groundwater), changes in regulation related to remediation of sites and establishments of threshold values. These requirements will be a part of Lithuania action plans for contaminated sites.

Groundwater and Drinking water

Groundwater is used as the main source of drinking water in Lithuania but potential contaminations have not been inventored. There are no actions or measurements related to groundwater ongoing at this moment (Lithuanian Geological Survey). But as mentioned, actions related to PFOS in groundwater will be included in the upcoming NIP. There was no information of analysis for PFAS in drinking water. According to the National Public health, PFAS analysis as not been conducted since it is not required in EU-regulations. No additional measurements were found in the scientfic literature.

Environmental data

PFOS has been monitored in water, sediments and biota of inland surface waters, transitional waters and Baltic Sea. Currently, a new National Monitoring Program (2018-2024) is prepared, which will include monitoring of PFOS of inland, transitional and coastal waters. Screening project on hazardous substances, including PFOS and PFOA, has been carried out (2014-2016) including different matrixes and WWTPs (project "Strengthening of marine and inland water management – part one"). During this screening project, AA-EQS for surface water was exceeded at some of the monitoring stations. However, there are no exceeding's of AA-EQS for biota. One scientific study was found, analyzing PFOS and PFOA in surface water, wastewater, sediments, sewage sludge, and biota (the samples were mainly from Lithuania but were analyzed by Latvia). Neither biota nor surface samples exceeded EQS values for the different matrixes but was detected in 84 and 67 % with median concentrations of 0.41ng/L and 0.22 ng/g, respectively (Zacs and Bartkevics, 2016).

Latvia

National strategies related to PFAS

According to the Ministry of Environmental Protection and Regional development of the Republic of Latvia, there is no existing national strategy for PFAS and environmental or health risks have not been identified. Currently, there is not sufficient information and measurements to estimate the size of problems related to PFAS. There is no on-going discussion about environmental issues coupled to the use of PFAS in fire fighting foams and potentially PFAS-sources have not been identified.

Firefighting foams

According to the State Fire and Rescue Service of Latvia there is no current use of fluorinated foams, instead they use the fluorine free foam STHAMEX F -15 (which has been used for more than 15 years). From this inventory it has not been stated if there may be possible uses of PFAS-foams at local self-government rescue departments or if PFOS based foams previously have been used within the Rescue Service. According to the National Defense Military Objects and Procurement Center, the National Armed Forces of Latvia does not use PFAS-foams (water and powder extinguishers are used) however, historically use of PFAS-foams are currently unknown. They are aware of environmental issues coupled to PFAS-foams (have attended conferences where this issue has been discussed) but the discussion has not been raised in Latvia yet.

Contaminated soil

Latvia has not inventoried PFAS-contaminated soil or established an action plan for soil contaminations. Since 2002-2005 a Register of Polluted and Potentially Polluted Sites was established used for soil remediation proposes. PFOS is currently not included in this register but the Ministry of Environmental Protection and Regional development of the Republic of Latvia, responded that possible future plans may be to add PFOS-issues for places where PFOS might be a polluter of concern.

Groundwater and Drinking water

Latvia does not monitor PFAS in driking water since it is not requiered in the Drinking Water Directive. There is no available information on possible appearance of PFAS in drinking water and therefore no currrent general discussion about issues regarding drinking water in Lativa (Health Inspectorate of Latvia). The main source of drinking water in Latvia is groundwater, but a large part of e.g. Riga city uses surface water from a water reservoir. According to the Latvian Environmental, Geological and Meteorological Centre , PFOS or other PFAS are not monitored in surface water nor groundwater (PFOS are monitored in biota). Groundwater may be relevant in the future but was not currently assumed to be relevant since EQS has not been exceeded in surface water or biota, therefore not suspected to be found in elevated concentrations in groundwater.

Environmental data

According to the Latvian Environmental, Geological and Meteorological Centre, PFOS and PFOA are monitored in freshwater biota (*Perca fluviatilis*) (since 2015). All samples ranged from 0.52- 1.97 µg/kg (total amount of PFOS and PFOA) and did not exceed AA-EQS of 9.1µg/kg. [49] Recently, a national screening analyzed PFOS and PFOA (among other hazardous substances) in effluents from the five

[49] http://www.meteo.lv/fs/CKFinderJava/userfiles/files/Vide/Udens/stat_apkopojumi/udens_kvalit/VPUK_parskats_2015.pdf Results for 2016 are under preparation

largest WWTPs in Latvia and in biota nearby the effluents. Concentrations of PFOS in effluents ranged from 0.44-0.78 ng/L (two samples exceeding AA-EQS of 0.64 ng/L). PFOS was detected in 16/25 biota samples ranging from 0.16-0.85 ng/g. PFOA ranged from 3.4- 6.4 ng/L in effluents and was not detected in biota (detection limit 0.15 ng/g).[50] In a previous screening study PFOS was detected in sludge but not in surface water or effluents from WWTPs (the lowest detection limit was higher than current AA-EQS).[51] There is no monitoring of PFAS in air and the University of Latvia has not conducted any research on this field. No additional measurement of PFAS was found in the scientific literature

Estonian

National strategies related to PFAS

There is no specific national action plan regarding PFAS in Estonia (e.g. to increase the knowledge and reduce the use of PFAS). According to the Ministry of the Environment, the NIP from 2013 includes information of PFOS being found in the environment as residues in circulation (landfill sites) and in products. In addition, the following actions are addressed:

1. PFOS impact needs to be clarifed
2. Waste management needs to be clarified
3. Circulation regulations of products containing PFOS (including foams)

According to the Ministry of the Environment, PFOS will be considered in national water monitoring programs when defining measures. Regularly inventory of emissions, discharges and losses of priority and priority hazardous substances will be prepared, including PFOS. As EQS substance, it is regulated in water bodies and also in effluents in order to eliminate its discharges to water body. Other hazardous substances are considered of greater concern in Estonia, compared to PFAS. From the incoming responds it has been assessed that there seems to be a lack of identification of possible environmental and health risks of PFAS and no ongoing discussion regarding contaminations related to firefighting foams has been identified.

Firefighting foams

The Estonian Rescue Board was not aware of issues related to PFAS-foams and there are no restrictions or recommendations when using foams. Currently, Estonia is using AFFF 3%, AFFF 1/3% and FP both during training and real accidents. The Estonian Defense force has not announced whether they use PFAS-foams or have any restrictions or recommendations.

[50] *Bīstamu ķīmisku vielu apsekojums Latvijas virszemes ūdeņos* (Survey of hazardous chemical substances in Latvian surface waters)

[51] http://baltacthaz.bef.ee/files/c15/c55/Latvian%20Screening_ENG.pdf

Contaminated soil

PFAS is not regulated in soil. Estonia mainly focuses on past pollutions (oil and heavy metals) of soil caused by former military and industrial activities. There have been no inventories related to PFAS-contaminated soil. PFAS discharges to soil are regulated, as PFAS is regulated in WWTPs effluents (results provided from the Ministry of the Environment).

Groundwater and Drinking water

Possible contaminated groundwater has not been inventoried according to the Estonian Environment Agency. There are no available measurements of PFAS in groundwater or drinking water. The Estonian Health Board stated that PFAS issues related to drinking water may exist (but undetected) in Estonia, but (monitoring of PFAS may be possible in the future).

Environmental data

In 2016, the first national water monitoring of PFOS was carried out in sediment (detected in one sample at levels of 36 µg/kg). PFOS monitoring in surface water bodies and sediment will continue and extend to freshwater and marine biota in 2017. In 2016, PFBA, PFDA, PFDoA, PFHxA, PFNA, PFOA, PFOS and PFUA was measured in surface water (44 samples each). PFHxA and PFOA was detected in highest concentration (near landfills) of 99 and 38 ng/L, respectively (PFOS was below detection limit of 4 ng/L) (data provided from the Environmental Board). Screening project of PFAS in surface water, marine waters, biota and WWTPs has been conducted analyzing PFOS, PFOA, PFDA and PFHxA in surface water in 2011 and 2012. However, the analytical methods only allowed detection limits of 30 and 10 ng/L (all samples were below detection limits) and it is therefore not possible to determine if AA-EQS was exceeded in any measurements.[52,53] Fishes from Gulf of Finland and Gulf of Riga were analyzed for PFOS, PFOA, PFNA, PFDA, PFUnA, PFDoA, PFTrA, PFHxS and PFDS in 2013-2014, most dominant of PFOS with average content of 1.06-1,75 µg/kg (Baltic herring). The highest total amount of PFAS in Perch was 9.43µg/kg.[54] According to the Ministry of the Environment trend analysis of PFOS will be carried out. No additional environmental measurements of PFAS were found in the scientific literature search.

[52] http://bef.ee/wp-content/uploads/2014/09/Reduction_recommendations_EST.pdf

[53] https://www.envir.ee/sites/default/files/elprioriteetsete_aruanne.pdf

[54] http://www.pria.ee/docs/resources/8894.pdf

Summary of results

National strategies and actions
Sweden is the only country in the BSR with a national action plan for PFAS. Denmark, Germany and Finland are in the process of developing national strategies and action plans, or are discussing PFAS in a broader picture. Finland and Sweden have national PFAS-networks. Poland, Estonia, Latvia and Lithuania do not have any coordinated actions on a national level. However, the Lithuanian EPA has started to discuss issues coupled to the use of PFAS-foams with firefighters.

Firefighting foams
Sweden and Germany have developed national recommendations when using PFAS-foams. In Sweden, national regulations of collection and destruction of foams used during training has been proposed. The Finnish military aviation only use PFAS-foams during accidents and the use is prohibited at fire training areas of airports. Denmark is aware of environmental risks coupled to the use of PFAS-foams but measures or guidelines are currently not an issue high on the agenda. No recommendations or restrictions were identified in Poland or Estonia, however, Poland are aware of environmental risks, mainly with regards to PFOS. Latvia and Lithuania do not use PFAS-foams, neither in local fire services nor defense organizations. Investigations on sites where PFAS-foams have been used have been conducted in Sweden, Denmark, Germany and Finland.

Contaminated soils
Sweden has partly inventoried contaminated soils, additionally; threshold values and a guideline have been developed to facilitate risk assessments. In Denmark, systematic mapping of PFAS contaminated soils is required, threshold value has been established and guidelines are currently being developed. Germany has inventoried some contaminated soils and developed a guideline how to identify sites. In Finland there are available actions aiming to identify and investigate risk of contaminated sites. No inventories, strategies or activities were identified in Poland, Latvia, Lithuania or Estonia.

Groundwater and drinking water
Swedish groundwater has been inventoried for PFAS-contaminations. Due to discovery of PFAS in drinking waters, water producers have conducted several measurements to control water quality. Danish groundwater and drinking water are controlled for PFAS at known contaminated sites and if there is a risk for contamination. PFAS-contaminated groundwater has been inventoried in Germany, and Finland is carrying out projects aiming to analyze for PFAS. Sweden, Denmark and Germany have established guideline/threshold values for PFAS in groundwater and drinking water. Finland is considering to develope national threshold values. No actions regarding PFAS-contaminated groundwater and drinking water have

been identified in Poland, Latvia, Lithuania or Estonia. However, the upcoming Lithuanian NIP will include actions related to groundwater (and contaminated soil).

Environmental data

Table 2 and 3 summarize the availability of regular environmental monitoring data for PFOS/PFOA and other PFAS, respectively. Table 4 and 5 summarize the availability of environmental data from screening studies, research and other projects for PFOS/PFOA and other PFAS, respectively. Note that the search of national research in the open scientific literature was briefly and that there may be additional available national screening studies (or information about regular monitoring) which have not been provided. Therefore, the numbers of substances given in the tables are indicative and may not be accurate.

In general, it seems like Sweden, Denmark, Germany and Finland have extended (e.g. including several PFAS or matrixes) their environmental monitoring and conducts reoccurring screenings in several matrixes. It was difficult to summarize the environmental monitoring in Germany since it seems to differ between the Federal States.

Measurements, other than requirements (e.g. biota), in Poland, Latvia, Lithuania and Estonia are from some screenings, the COHBIA project and some public available research projects. However, Lithuania and Estonia monitor PFOS in sediment on a regular basis. Further, no measurements of groundwater or drinking water was found for these countries, with the exception of Poland where tap-water has been investigated once. In addition, no target screenings (e.g. near fire training sites) were identified in these countries.

Table 2. Regular monitoring of PFOS and PFOA (PFOA are indicated with gray).

	Freshwater	Marine water	Ground water	Drinking water	Biota (freshwater)	Biota (marine)	Sediment	WWTP	Air
SE	(No)	No	(No)	(No)	Yes	Yes	(No)	Yes	Yes
DK	(Yes)	No	Yes	Yes*	Yes*	Yes	(Yes)	Yes*	No
DE	Yes	Yes	No	No	Yes	Yes	No	No	No
FI	No	No	No	No	Yes	Yes	No	No	No
PL	No	No	No	No	Yes	Yes	No	No	No
EE	Yes	Yes*	No	No	Yes*	Yes*	Yes	No	No
LV	No	No	No	No	Yes	No	No	No	No
LT	Yes	Yes	No	No	Yes	Yes	Yes	No	No

Table 3. Regular monitoring of other PFAS (excluding PFOS and PFOA). The numbers indicates how many substances included.

	Freshwater	Marine waters	Ground waters	Drinking water	Biota (freshwater)	Biota (marine)	Sediment	WWTP	Air
SE	(No)	No	(No)	(No)	>10	>10	(No)	>10	>10*
DK	(Yes)	No	10	10*	4*	4	(Yes)	4*	No
DE	No	No	No	No	(No)	(No)	No	No	No
FI	No	No	No	No	>10	No	No	No	No
PL	No	No	No	No	No	No	No	No	No
EE	No	No	No	No	No	No	No	No	No
LV	No	No	No	No	No	No	No	No	No
LT	No	No	No	No	No	No	No	No	No

*Upcoming plans. (Yes)= previous monitoring which not will continue. (No)= No regular monitoring but recurring monitoring and screenings

Table 4. Environmental data for PFOS and PFOA from screening studies or research (PFOA are indicated with grey) (Yes)= detection limit was higher than 0.65 ng/L (AA-EQS).

	Surface water	Marine water	Ground water	Drinking water	WWTPs	Sludge	Biota	Predators	Sediment	Air
SE	Yes[a]	Yes[a]	Yes[a]	Yes[ab]	Yes[ac]	Yes[ac]	Yes[ab]	Yes[b]	Yes	Yes[a]
DK	Yes[a]	Yes[a]	Yes[a]	Yes	Yes[ac]	Yes[bac]	Yes[ab]	Yes[b]	Yes[a]	No
DE	(Yes)[b]	Yes[a]	Yes[b]	Yes[b]	Yes[bc]	Yes[bc]	Yes[b]	Yes[b]	Yes[b]	Yes[b]
FI	Yes[a]	Yes[a]	Yes	Yes	Yes[bc]	Yes[bac]	Yes[ab]	Yes[a]	No	No
PL	Yes[b]	No	No	Yes[b]	Yes[c]	Yes[c]	Yes[ba]	Yes[b]	Yes[b]	No
EE	(Yes)[b]	(Yes)[b]	No	No	Yes[bc]	Yes[c]	Yes[b]	No	No	No
LV	(Yes)[a]	No	No	No	Yes[abc]	Yes[ac]	Yes[a]	No	No	No
LT	Yes[b]	No	No	No	Yes[bc]	Yes[c]	Yes[b]	No	Yes[b]	No

Table 5. Environmental data of other PFAS (other than PFOS and PFOA) from screening studies or research. Numbers indicates how many substances included.

	Surface water	Marine water	Ground water	Drinking water	WWTPs	Sludge	Biota	Predators	Sediment	Air
SE	>10[ab]	6[a]	>10[ab]	>10[ab]	>10[abc]	>10[abc]	>10[ab]	>10[ab]	>10[ab]	>10[a]
DK	6[a]	6[a]	10[a]	>10[a]	6[abc]	5[bc]	5[ab]	4[b]	6[a]	No
DE	10[b]	>10[a]	>10[b]	10[b]	10[bc]	5	>10	7[b]	>10	>10
FI	>10[a]	6[a]	>10[a]	>10[a]	>10[c]	>10[bc]	>10[b]	No	6[a]	No
PL	10[b]	No	No	10[b]	2[c]	2[c]	2[b]	2[b]	7[b]	No
EE	6[a]	No	No	No	2[ac]	2[c]	7[a]	No	No	No
LV	No	No	No	No	2[c]	2[c]	No	No	No	No
LT	No	No	No	No	2[c]	2[c]	No	No	No	No

a= Screening, b= Research, c= measurements within the COHBIA project. *Upcoming plans.

Analysis

National awareness, strategies and activities related to PFAS vary significantly between countries in the region. Some countries restrict their activities to requirements by European regulations (e.g. monitoring), while others actively lead dialogue with EU Commission. Many countries stress the lack of knowledge.
While some countries have started significant investigations, others have not yet had the capacity or possibility to do national inventories or investigations. Countries with increased awareness have either developed a network and/or increased the horizontal dialog between policy sectors and stakeholders.

Interestingly, there is no current use or information about historically use of fluorine foams in Latvia and Lithuania. While, all other countries use fluorine foams (to some extent limited to accidents). However, a full-overview of the use of fluorine foams is difficult due to many different actors (e.g. local fire and rescue services, industrial sites, military, airports etc.).

Since fluorine foams are used within several actors and areas, it is also difficult to identify and inventor contaminated sites. Countries that have started to identify sites and coupled risks have mainly focused on military areas. However, there are still no proper remediation technics which means that contaminations are removed when disposed of. There is a need to develop new and cost-efficient remediation methods for PFAS contaminated soils.

PFAS-contaminated groundwater and drinking water are of specific concern for human health however, few countries have a clear overview of the problem. Poland, Latvia, Lithuania and Estonia have not identified any contaminated sites nor conducted any measurements.

Some countries have extended their environmental monitoring to several PFAS and/or conduct reoccurring national screenings. While, many countries focus on PFOS or PFAS “new” and short chained PFAS has reviled limited attention. Extended measurements e.g. of different matrixes near potential contaminated sites are necessary to estimate the occurrence and possible risks of PFAS.

As the knowledge and awareness varies within the region, it is necessary to transfer knowledge from countries that have come further in the process of developing national actions. For example, PA Hazards could facilitate a regional workshop to increase the general knowledge and awareness of PFAS within the BSR. In addition, PA Hazards and PA Secure could make a joint effort to improve the knowledge and awareness of the environmental effects of PFAS containing foams to the regional fire and rescue services. PFAS issues are complex and require measures including several policy sectors and stakeholders. It is necessary to

include or extend the dialog in existing networks such as: HELCOM, EUSBSR, ENDWARE and NBDE.

Bibliography

Ahrens L, Siebert U, Ebinghaus R. 2009. Total body burden and tissue distribution of polyfluorinated compounds in harbor seals (*Phoca vitulina*) from the German Bight. *Marine Pollut. Bull.*, 58 (2009), pp. 520–525

Ahrens L, Norström K, Viktor T, Cousins AP, Josefsson S. 2015. Stockholm Arlanda Airport as a source of per- and polyfluoroalkyl substances to water, sediment and fish. *Chemosphere* 129: 33–38

Becker AM, Gerstmann S, Frank H. 2008. Perfluorooctane surfactants in waste waters, the major source of river pollution. Chemosphere 72(1): 115-121

Bossi R, Strand J, Sortkjær O, Larsen MM. 2008. Perfluoroalkyl compounds in Danish wastewater treatment plants and aquatic environments. *Environment International* 34(4):443-450

D'Hollander W, de Voogt P, De Coen W, Bervoets L. 2010. Perfluorinated substances in human food and other sources of human exposure. *Rev Environ Contam Toxicol* 208:179–215

Dietz R, Rigér FF, Galatius A, Sonne C, Teilmann J, Bossi R. 2012. Spatial trends of perfluorochemicals in harbor seals (*Phoca vitulina*) from Danish waters. *Science of The Total Environment* 414: 732-737

DK EPA, 2015. *Short-chain Polyfluoroalkyl Substances (PFAS).* (No. 1707, 2015). Denmark: Danish Ministry of the Environment -Environmental Protection Agency.

Dreyer A, Kirchgeorg T, Weinberg I, Matthias V. 2015. Particle-size distribution of airborne poly- and perfluorinated alkyl substances. Chemosphere 129: 142-149

EFSA (2011). *Results of the monitoring of perfluorioalylated substances in food in the period 2000-2009.* Italy, Parma: European Food safety Authority

Falandysz J, Taniyasu S, Yamashita N, Rostkowski P, Zalewski K, Kannan K. 2007. Perfluorinated compounds in some terrestrial and aquatic wildlife species from Poland. *Journal of Environmental Science and Health Part A* 42:715-719

Falandysz J, Rostkowski P, Jarzynska G, Falandysz JJ, Taniyasu S, Yamashita N. 2012. Determination of perfluorinated alkylated substances in sediment and sediment core from the Guld of Gdansk, Baltic Sea. *Journal of Environmental Science and Health, Part A: Toxic/Hazardous Substances and Environmental Engineering* 47(3): 428-434

Filipovic M, Berger U, McLachlan MS. 2013. Mass balance of perfluoroalkyl acids in the Baltic Sea. *Environ. Sci. Technol* 47: 4088–4095

Filipovic, M., Woldegiorgis A, Norström K, Bibi M, Lindberg M, Österås AH. 2015. Historical usage of aqueous film forming foam: A case study of the widespread distribution of perfluoroalkyl acids from a military airport to groundwater, lakes, soils and fish. *Chemosphere* 129: 39–45

Galatius A, Dietz R, Rigér FF, Sonne C, Kinze CC, Lockyer C, Bossi R. 2011. Temporal and life history related trends of perfluorochemicals in harbor porpoises from the Danish North Sea. *Marine Pollution Bulletin* 62 (7): 1476-1483

Gyllenhammar I, Berger U, Sundström M, McCleaf P, Eurén K, Eriksson S, Ahlgren S, Lignell S. 2015. Influence of contaminated drinking water on perfluoroalkyl acid levels in human serum—A case study from Uppsala, Sweden. *Environmental Research* 140: 673–683.

Jahnke A, Berger U, Ebinghaus R, Temme C. 2007. Latitudinal Gradient of Airborne Polyfluorinated Alkyl Substances in the Marine Atmosphere between Germany and South Africa (53° N−33° S). *Environ. Sci. Technol.* 41: 3055-3061

Jakobsson K, Kronholm Diab K, Lindh C, Persson B, Jönsson B. 2014. Exposure to perfluorated substances (PFAS) in drinking water in the municipality Ronneby Arbets- och miljömedicin, Medicinsk service, Region Skåne i samarbete med Arbets- och miljömedicin vid Lunds Universitet, rapport nr 8/2014, Lund, Sweden (in Swedish).

Kannan K, Corsolini S, Falandysz J, Oehme SF, Giesy JP.Perfluorooctanesulfonate and Related Fluorinated Hydrocarbons in Marine Mammals, Fishes, and Birds from Coasts of the Baltic and the Mediterranean Seas. *Environ. Sci. Techol.* 36: 3210-3216

KEMI. (2014). *Kartläggning av brandsläckningsskum.* (511 126). Stockholm: Kemikalieinspektionen. Retrieved 15 May: https://www.kemi.se/global/pm/2014/pm-3-14.pdf

KEMI 2015.Occurrence and use of highly fluorinated substances and alternatives. Swedish Chemicals agency. Accessed from: https://www.kemi.se/global/rapporter/2015/report-7-15-occurrence-and-use-of-highly-fluorinated-substances-and-alternatives.pdf (12 April, 2017)

KEMI 2016a. Strategi för att minska användningen av högfluorerade ämnen, PFAS. Stockholm: Kemikalieinspektionen. Rapport 9/16. ISSN 0284-1185

Koponen J, Airaksinen R, Hallikainen A, Vuorinen PJ, Mannio J, Kiviranta H. 2015. Perfluoroalkyl acids in various edible Baltic, freshwater and farmed fish in Finland. *Chemosphere* 129:186-191

Naturvårdsverket. 2016. Högfluorerade ämnen (PFAS) och bekämpningsmedel. Rapport 6709. Mars 2016. Naturvårdsverket, Stockholm

OECD, 2013. OECD/UNEP Global PFC Group. Synthesis Paper on Per- and Polyfluorinated Chemicals (PFCs). Environment, Health and Safety, Environment Directorate, OECD, Paris, France.

Prevedouros, K., Cousins, I. T., Buck, R. C. & Korzeniowski, S. H. (2006). Sources, fate and transport of perfluorocarboxylates. *Environ. Sci. Technol. Vol.* 40: 32–44.

Rostkowski P, Taniyasu S, Yamashita N, Falandysz J. 2008. Perfluorinated compounds in portable water. *Rocz. Panstw. Zakl. Hig*., 59: 283–292 (only abstract)

Rostkowski P, Taniyasu S, Yamashita N, Falandysz JJ, Zegarowski Ł, Chojnacka, A, Pazdro K, Falandysz, J. 2009. Survey of perfluorinated compounds (PFCs) in surface waters of Poland. *Journal of Environmental Science and Health, Part* A, 44(14): 1518 — 1527

Rüdel H, Müller J, Jürling H, Bartel-Steinback M, Koschorreck J. 2011.Survey of patterns, levels, and trends of perfluorinated compounds in aquatic organisms and bird eggs from representative German Ecosystems. Enviromental Science and Pollution Research 18:1457-1470

Schuetze T, Heberer T, Effkemann S, Juergensen S. 2010. Occurrence and assessment of perfluorinated chemicals in wild fish from Northern Germany. *Chemosphere* 78: 647–652

Skutlarek, D., Exner, M., Färber, H., 2006. Perfluorinated surfactants in surface and drinking waters. *Environ. Sci. Pollut. Res*. Int. 13, 299–307.

Surma M, Gizejewski Z, Zielinski H. 2015. Determination of perfluorinated sulfonate and perfluorinated acids in tissues of free-living European beaver (*castor fiber* L.) by d-SPE/ micro-UHPLC-MS/MS. Ecotoxicology and Environmental Safety 120:436-444

Wang, Z., Cousins, I.T., Scheringer, M. & Hungerbuehler, K. (2015). Hazard assessment of fluorinated alternatives to long-chain perfluoroalkyl acids (PFAAs) and their precursors: Status quo, ongoing challenges and possible solutions. *Environment International.* 75*:* 172-179.

Wang Z, DeWitt JC, Higgins CP, Cousins IT. 2017. A Never-Ending Story of Per- and Polyfluoroalkyl Substances (PFASs)?, Environmental Science & Technology. 51(5): 2508-2518

Weinberg I, Dreyer A, Ebinghaus R. 2011. Waste water treatment plants as sources of polyfluorinated compounds, polybrominated diphenyl ethers and musk fragrances to ambient air. *Environmental Pollution* 159(1): 125-132

Willach S, Brauch HJ, Lange FT. 2016. Contribution of selected perfluoroalkyl and polyfluoroalkyl substances to the adsorbable organically bound fluorine in German rivers and in a highly contaminated groundwater. *Chemosphere* 145: 342-350

Zacs D, Bartkevics V. 2016. Trace determination of perfluorooctane sulfonate and perfluorooctanoic acid in environmental samples (surface water, wastewater, biota, sediments, and sewage sludge) using liquid chromatography – Orbitrap mass spectrometry. *Journal of Chromatography A* 1473: 109-121.

Zhao Z, Xie Z, Tang J, Zhang G, Ebinghaus R. 2015. Spatial distribution of perfluoroalkyl acids in surface sediments of the German Bright, North Sea. *Science of The Total Environment* 511: 145-152

Appendix 1- Listing of authorities

All authorities invited to participate in the inventory by answering questionnaires sent via email are listed below.

Sweden
Geological Survey of Sweden (SGU)
Swedish Environmental Protection Agency
Swedish Geotechnical Institute (SGI)
Surgeon General
The Water Authorities

Denmark
Danish Centre for Environment and Energy
Danish Emergency Management Agency (DEMA)
Danish Environmental Protection Agency
Danish Regions
Danish Veterinary and Food Administration (DVFA)
Ministry of Defense's Property Agency
Ministry of Environment and Food Agency for Water and Nature Management (EPA)

Germany
Hessian Ministry for the Environment, Climate Protection, Agriculture and Consumer Protection
Federal Maritime and Hydrographic Agency
Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMUB)
Federal Ministry of Defense (MOD)
Fire brigade Stuttgart
German Federal Environment Agency (UBA)
German Federal Ministry of Health
State Agency for Agriculture, Environment and Rural Areas of the German Federal State Schleswig-Holstein (Department of Waters, Division of Groundwater Hydrology, Groundwater Protection; Division of Coastal Waters; Division of Streaming Waters and Ecology)

Finland
Defense Command Finland
Finnish Environment Institute (SYKE)
Finnish National Institute for Health and Welfare
Finnish Safety and Chemicals Agency
Ministry of the Environment Finland
Ministry of the Interior of Finland (Department for Rescue services)

Social and health Ministry

Poland
Bureau for Chemical Substances
Chief Inspectorate of Environmental Protection (GIOŚ) (Department of Monitoring and Environmental information)
Chief Sanitary Inspectorate (Department of Water Health Safety)
Department of Agriculture and Environmental Protection
Environmental Protection Agency
Gdansk University
Institute of Meteorology and Water Management
Institute of Environmental Health (Environmental Hygiene Department)
Institute of Soil Science and Plant Cultivation
International Cooperation Department (National Headquarters of the State Fire Service)
Krakow Technical University
Main Inspectorate of Environmental Protection
Main School of Fire Service in Warsaw
Maritime Institute in Gdańsk
Ministry of the Agriculture
Ministry of Development (Department of Industrial Regulation)
Ministry of the Environment (Department of water Resources, Geological
Regional Director of Environmental Protection Supervision)
Ministry of Maritime Economy and Inland Waterways
National Institute of Public Health
National Water Management Authority (KZGW)
The Inspector for Chemical Substances
The National Headquarters of the State Fire Service
The Polish Armed Force
The Polish Geological Institute

Estonia
Environmental Board
Estonian Environment Agency
Estonian Defense Forces
Estonian Environmental Research Center
Estonian Health Board
Estonian Rescue Board
Ministry of the Environment
Ministry of Social Affairs
Tartu University

Latvia
Centre for State Defence Military Real Estate and Procurement
ELLE (Estonian, Latvian & Lithuanian Environment)

Faculty of geography and earth sciences, laboratory of environmental quality monitoring
Health Inspectorate of Latvia
Latvian Environmental, Geology and Meteorology Center
Latvian Institute of Aquatic Ecology (LHEI)
Latvian University, Faculty of Analytical chemistry (Institute of Food Safety, Animal Health and Environment)
Ministry of Environmental Protection and Regional Development of the Republic of Latvia
Ministry of Defense of the Republic of Latvia
Ministry of Health of the republic of Latvia
State Environmental Service of Latvia (Director of Fishery control department and Environmental resource management department)
State fire and Rescue service of Latvia

Lithuania
Center of Marine research
Fire and Rescue Department Lithuania
Institute of Ecology and Industrial areas
Lithuania Armed Forces
Lithuanian Environmental Protection Agency (Chemical division, Water status, Air division, Chemical analysis, Pollution Prevention)
Ministry of the Environment
National Public Health (NVSPL)
National environmental protection inspections
National public health surveillance laboratory
Occupational Health Centre

Appendix 2- Incoming answers

Incoming answers from the participants are presented below.

*Answer collected from mail correspondence
** Answers provided from KEMI (Nordic PFAS-workshop)

National strategies related to PFAS

1. Does your country have a national action plan for PFAS-substances (e.g. to increase the knowledge or reduce the use of PFAS?)			
Answer		Comment	Respondent
SE	Yes	PFAS is part of KemIs "Action Plan Non-Toxic Everyday Environment (2015-2020)". KemI has developed a strategy for reducing the use of PFAS aiming at minimising and eventually discontinuing the uses which could cause environmental pollution.SE Government has commissioned KEMI to develop an cross-cutting action plan for natl., EU and international initiatives (deadline Sept 2017).**	Swedish EPA
DK	(No)	DK has currently no long term action plans for PFASs under REACH/CLP. However, PFASs is considered a focus area and DK are involved in the development of an EU strategy (with Sweden as lead). The Danish Veterinary and Food Administration (DVFA) discourage the use of fluorinated substances in paper and board food packaging materials.**	DK EPA/ DK DVFA
DE	No	None**	UBA
FI	(Yes)	Only related to PFOS in the National implementation plan (NIP) of the Stockholm Convention.**	SYKE
PL	No		Bureau for Chemical Substances
EE	No	No specific national strategy or action plan for PFAS substances. As PFOS is included to EQS directive, it is included, like any other EQS substance, to water management plans prepared according to WFD.	Ministry of the environment
LV	No		Lithuania EPA
LT	Yes	Lithuania has Persistent Organic Pollutants (POPs) Management Program (regard to the Stockholm Convention on Persistent Organic Pollutants) approved by the Ministry of Environmental of the Republic of Lithuania. PFOS is on the list of priority hazardous substances in the Regulation on. Wastewater Treatment approved by Order of the Minister of Environment.	Ministry of Environmental Protection and Regional development of the Republic of Latvia

2. Does your country have a national network (for knowledge exchange and cooperation) regarding PFAS-issues?		
Answer		Comment
SE	Yes	The network includes several researcher, municipalities, water producers and authorities (e.g. Swedish EPA, KEMI, National food agency)
DK	No	
DE	(Yes)	An expert network exists within the BLANO (Bund/Länder Ausschuss Nord- und Ostsee) regarding marine waters (WFD and MSFD)
FI	Yes	We have a PFAS network of ministries (ministry of the environment, ministry of social affairs and health, ministry of agriculture and forestry), national agencies and research institutes (Finnish environment institute (SYKE), National institute for health and welfare (THL), Finnish safety and chemicals agency (Tukes)), national and regional authorities (National supervisory authority for welfare and health (Valvira), Centres for economic development, transport and the environment (ELY centres)), The Finnish defence forces, Construction establishment of defence administration, Finnish Water Utilities Association (FIWA), and Finavia. The network meets approximately once a year to discuss PFAS issues, recent developments and needs.
PL	No	
EE	No	No such specific network established
LV	No	
LT	No	

3. Is there an ongoing discussion about environmental issues coupled to PFAS in fire-fighting foams in your country?		
Answer		Comment
SE	Yes	
DK	(No)	This is currently not an issue that is high on the agenda in Denmark (DK EPA)
DE		
FI	Yes	The discussion is mainly professional e.g. among the PFAS network, companies with contaminated sites, and firefighters concerned on their own health. I haven't seen any public discussions on this issue e.g. in press or social media. The public is more concerned about PFAS in consumer products.
PL	No	I am not aware of any ongoing discussion on PFAS contamination on the national level.*
EE	No	No such discussions ongoing
LV	No	-
LT	Don't know	-

4. Has potentially sources of PFAS been identified in your country *(e.g. near fire training sites or landfills)*?		
Answer		Comment
SE	Yes	Over 2000 potentially sources (emissions to soil, water and air) has been inventoried (firefighting sites, WWTPs and disposals)

DK	Yes	
DE	(Yes)	MOD has investigated and identified contaminated sites within the Federal Defence
FI	Yes	The potential sources have been inventoried and some identified, but I do not think the issue is yet in control. Main focus has been in fire training sites, because they are the easiest to locate and are usually major polluters of soil, groundwater and surface waters locally. PFAS have also been screened in wastewaters, and groundwaters that are used for drinking water production. Only very few landfill leachates have been studied for PFAS.
PL	No	
EE	No	PFOS is in national surface water monitoring program since 2016. Not detected from surface waters.
LV	No	
LT	(Yes)	During the project "Strengthening of marine and inland water management – part one", which was implemented by the LT02 program "Integrated marine and inland water management" (funded by the EEA Financial Mechanism 2009–2014) PFOS was measured and detected in wastewaters of different economic activities, especially in wastewater of such economic activities like: production of chemicals and chemical products, production of rubber and plastic products and in wastewater treatment plants.

5. Has your country identified any health or environmental risks/issues related to PFAS? ***(e.g. near specific sites or in drinking water)***	
	Answer
SE	Measured levels in the environment shows that there is a risk for humans and the environment are exposed to PFAS at concentrations that may have negative effects (highest risk at areas close to contamination of sites caused by firefighting foams). Several drinking water supplies have been closed due to PFAS contamination. Health surveys of the most affected communities are ongoing, but there is no results yet. **
DK	No, the issue with organic fluorinated substances in food contact materials is not specific to DK. Recent studies have shown the presence of these substances in paper and board food contact materials from US and a range of European Countries.**
DE	HBM I values for Perfluorooctanoic acid (PFOA) and Perfluorooctane-sulfonic acid (PFOS) in blood plasma were calculated by the German Human Biomonitoring Commission (HBM Commission): Based on an assessment of the literature on animal and human epidemiological studies which it discussed during its last meeting in May 2016, and following clarification of a few open details, the HBM Commission has decided to set HBM I values for PFOA and PFOS in blood plasma of 2 ng PFOA/ml and 5 ng PFOS/ml.**
FI	Yes. Sites that have been contaminated from the use of PFAS AFFF. The extent in the whole country is not yet fully known, nor the risks related to concentrations. More information should be collected on sites where AFFF have been used in the past.
PL	We are aware of risk related to organic fluorinated substances in general, however there was no specific discussion on risk related to PFAS. **
EE	No. Not detected from drinking water
LV	No
LT	No

6. What do you consider being the biggest issues related to PFAS?	
	Answer
SE	The extreme persistency and wide-spread use of thousands of PFAS, often in unknown applications.**
DK	The fluorinated organic substances form a large group of substances. Currently, we only have information of their health effects for very few of them. This is a challenge that requires research into the identification of, exposure to and toxicity of these chemicals.**
DE	• Short-chain PFASs are persistent and mobile and can occur in raw water and can therefore be found in drinking water. • Short-chain PFASs cannot be eliminated from water with the commonly applied measures. Furthermore, modern technologies are ineffective in removing short-chain PFASs from water. • Ubiquitous presence of short-chain PFASs in aquatic systems might lead to continuous background exposure to short-chain PFASs. • Short-chain PFASs can be taken up by plants and have already been found in edible crops. • Exposure via food might lead to increased exposure, due to the consumption of water rich edible plant (parts) contaminated with short-chain PFASs. • Short-chain PFASs show a relevance in organisms: - toxicokinetic experiments illustrate bioavailability of short-chain PFASs. - protein interactions are similar to that of long-chain PFASs. - the half-lives of short-chain PFASs enable sufficient exposure durations for provoking adverse effects in organism. • Exposure via background concentrations of short-chain PFASs may affect sensible population groups or development stages. • Due to the prognosticated increasing use of short-chain PFASs (based on substitution of long-chain PFASs), background concentrations might reach toxic levels. Effects cannot be sufficiently predicted and experimental data are not suited to describe potential long term effects with adequate clarity.**
FI	Water resource contamination from contaminated sites and past use of AFFF. This will require extensive screening/monitoring as well as continued drinking water monitoring. Issues related to sampling and analysis of man-made materials (e.g. carpets, textiles) which should be sorted out to facilitate enforcement. PFAS are used in low concentrations and standard is only available for PFOS**
PL	We do not identified any specific risks for PFAS, different then other organic fluorinated substances. Generally we are aware of PFOS and PFAS properties and associated risks.*
EE	PFAS is not really an issue in Estonia compared with other substances
LV	Currently I can't answer. Taking into account that we start monitoring of PFAS substances in surface water (only) several years ago currently available information is not sufficient to estimate what issue related to PFAS could be the biggest and whether these substances really cause a problem in our country.
LT	Lack of data on sources, concentrations in groundwater and drinking water

7. Are there any ongoing/upcoming activities in your county such as regulation, monitoring, research etc.?	
	Answer

SE	The following activities are **ongoing** in Sweden: • Nomination of PFHxS as a Substance of very high concern (SVHC) under REACH • Producing a brochure with advice to fire-fighters as to how to use AFFF in a responsible manner. • Proposing national legislation on the use responsible of AFFF. • Monitoring (Swedish EPA): Trend monitoring: - Biota (fish, guillemot eggs); Sewage effluent and sludge and Air Screening studies/monitoring (not yearly): - Eggs from white tailed sea eagle and osprey - Otters - Retrospective study on archived STP sludge: total organic fluorine targeted PFAS. - Screening of "ultra short" PFAS - One year monitoring of riverine input to the sea (10 rivers 4x/year) 26 PFAS • Guidance on PFAS and contaminated areas (SEPA and SGI) • Project on PFAS and waste management (consultant Sweco commissioned by the Swedish Waste Management Association) • Research project EnForce 2017-2022 The following activities are **upcoming** in Sweden: • Reach restriction of long-chain perfluoroalkyl acids • Contributing to a potential EU strategy for PFAS • National monitoring (Swedish EPA) - Screening of PFPiAs and PFPAs (including a long range of other PFAS) - Screening of total organic fluorine and "emerging PFASs" such as ADONA, GenX, F53-B (including a long range other PFAS) - Monitoring of blood from approx. 800 individuals, "emerging PFAS" in approx. 40 samples. - Increased air monitoring (from 1 to 3 stations and more PFAS)**
DK	In Denmark the EPA has currently no long-term action plans for PFAS (but PFASs are considered as a focus area and Denmark is involved in the development of an EU strategy) Following activities are **ongoing** in Denmark: • Regulation: Restriction proposal for polyfluorsilanes in spray products for consumers. RMOA for PFBA (focus on harmonised classification based on existing data). (DK EPA) • Research: DTU Food is conducting *in vivo* ED test on PFHxS (paper not published yet). The National Research Centre for the Working Environment (NRCWE) is conducting acute tox *in vitro* and *in vivo* on 22 impregnation products for spray application (paper not published yet). (DK EPA) • Research: DTU Food is investigating the analysis method for determining total organic fluorine in paper and board food packaging materials. Also, DTU food is looking into background levels of total organic fluorine in paper and board from sources other than the use as impregnation agents. (DK DVFA) • Screening: Denmark will in 2017 be involved in a screening study on fluorinated compounds initiated by the Joint Nordic Screening Group. Focus will be on "new" fluorinated compounds and total organic fluorides in as well aquatic samples as biota. • The EU Commission published a recommendation 2010/161 on the monitoring of

	perfluoroalkylated substances in food. Member states should monitor PFOS, PFOA and if possible their precursors (PFOSA, NEtFOSE and 8:2 fluortelomer alcohol), compounds similar to PFOS and PFOA (C4-C15) and PAPS (8:2 di PAPs and 8:2 monoPAPS) in food of animal (e.g. fish, meat, eggs, milk and derived products) and plant origin. The Danish Veterinary and Food Administration has monitored PFOS and PFOA in these foods since 2011. Member States have submitted their analytical results to the European Food Safety Authority, EFSA, which in 2012 published a risk assessment of the content of these substances in food.**
DE	The following activities are **ongoing** in Germany: • Research project 2016-2018: PFAS in building products (e.g. paints, lacquers) and technical textiles (e.g. car seats, water filters) • Research project 2016-2018: data collection for preparation of restriction proposals for PFAS (industry survey) • Substance evaluation of PFHxA-precursors (2016), 4 fluoroethers, such as ADONA and GenX (2017), 2 PFBA precursors (2018) • Restriction proposal for C9-14 PFCAs, their salts and related substances (2017) • RMOA for PFHxA (2017) • Projects at German Environmental Specimen Bank The following activities are **upcoming** in Germany: • REACH regulation of short chain PFASs beginning with PFHxA • Research project on phytoremediation of soil contaminated with PFASs (2017-2019) • Research project on novel PFASs 2018-2020**
FI	The following activities are **ongoing** in Finland: • Regulation: REACH • Monitoring: a groundwater and contaminated site survey carried out. Waterworks now measure the PFAS compounds in the incoming water. • Continued monitoring in the Gulf of Finland following an isohexane fire in 1989 (large amounts of PFOS containing AFFF was used). • Environmental monitoring campaigns of PFAS in biota + WFD • Research: Contaminated sites remediation study Following activities are **upcoming** in Finland: • Further carry out environmental monitoring studies in high-risk areas (airports, fire-fighting training areas) and extend to groundwater contamination. • Following the potential additional regulation of PFOA and short chain PFAS, develop further management actions. • Risk assessment of PFAS contaminated sites, esp. related to groundwater quality. • The risks caused by landfills remain to be addressed. • Research/ screening project for updating WFD & MSFD monitoring http://www.syke.fi/hankkeet/uupri**
PL	PFOS monitoring is regulated in surface water bodies (biota and sediment matrices monitored so far) and it is monitored within the frames of national monitoring programme since 2016
EE	PFAS (PFOS) is regulated in surface water bodies and bottom sediments, therefore it is monitored within the frames of national monitoring programme since 2016. PFAS (PFOS) is also substance, for

	which trend analysis will be carried out. As one of the EQS substances, it will be taken into account in river basin management plans prepared according to requirements of WFD. As it is regulated in surface water it is also regulated in effluents discharged into water bodies
LV	Since 2015 PFOS /PFOA are included in the state monitoring program of surface water (in biota organisms – fish). Latvia participates in the ongoing project NonHazCity (Interreg Baltic Sea Region Programm 2014-2020). Among other substances it is planned to analyze PFAS in Riga – the biggest city of Latvia. In 2016 PFOS /PFOA were analyzed in the frame of national screening project – in treated wastewater samples from biggest wastewater treatment plants. Maybe there could be some groundwater screening project, but as we have not found EQS exceedings in surface water biota, then it is not suspected to be found in groundwater.
LT	Lithuania is preparing new National Monitoring Programme for the period of 2018-2024. PFOS will be included in the monitoring of inland, transitional and coastal waters. According ”POPs Management Program for Years 2017-2025” upcoming activities: -inventory of POPs potentially contaminated sites (PCS) including PFAS; -Soil and Groundwater monitoring; -changes in regulation related to remediation of orphan sites contaminated with POPs and establishment of threshold values (from Lithuanian Geological Survey)

Firefighting foams

1. What type of foams does your organization use? *(e.g. are you using fluorine based foams)*		
	Answer	Respondent
SE	The Swedish armed force is only using AFFFs during accident and at one training site. Otherwise, during training foams without PFAS are used.	Swedish EPA/ Surgeon General
DK	To my knowledge we don’t use AFFF within the Danish Emergency Management Agency (DEMA). We have no central registration of the use of foam in airports and in the local municipalities.* Neither the EPA or the DEMA knows if the Danish Defense force still uses PFAS-foams. I have contacted the Danish Defense force to get more information but I haven’t got an answer yet.* According to Ministry of Defense's Property Management: I can´t give you an straight answer if PFAS-foams currently is used within the Danish defense. We are looking at this question right now. There shouldn´t be, but the problem is to get the information from the producer sense you don´t have to tell the content if it is very low (not obligated to list substances that is below 0,1 % for most PFAS and 0,005 % for PFOS).*	Danish EPA/ Danish Emergency Management Agency/ Ministry of Defense's Property Management
DE		UBA
FI	The military aviation use AFFFs during accidents (not during training).*	Ministry of the Interior of Finland / Defense Command Finland
PL	In Poland are used the following products of foreign producers: AFFF, FP and STHAMEX F-15*	Ministry of Economic Development

EE	We use three types of foams - AFFF 3%; AFFF 1/3%; FP. My college said, that these foams are used also during trainings.*	Rescue Board
LV	Latvian Fire and Rescue Service does not use fluorinated foam for extinguishing fires. Our service for more than 15 years using environmentally friendly STHAMEX products.* According to the National Defense Military Objects and Procurement Center, the National Armed Forces of Latvia does not use PFAS-foams (water and powder extinguishers are used).	State Fire and Rescue Service of Latvia/ National Defense Military Objects and Procurement Center
LT	STHAMEX F-15 and Fomtec MB-20 (flourine free) are used according to the Fire and Rescue Department*. Lithuanian Armed Forces do not (and did not) use PFAS-based fire-fighting foams.*	Fire and Rescue Department Lithuania/ Lithuanian Armed Force

2. Is your organization aware of the environmental issues coupled to the use of fire-fighting foams containing PFAS-substances? *(e.g. have you heard about this issue before?)*		
Answer		Comment
SE	Yes	Swedish Civil Contingencies Agency (MSB) is included in the Swedish national PFAS-network, cooperating regarding issues related to PFAS. The Swedish Armed force is also aware of this problem and is yearly publishing environmental reports including PFAS-issues. Lately, PFAS has been prioritized and the Swedish army and The Swedish Fortifications Agency (Fortifikationsverket) have conducted surveys to investigate sites where fire-fighting foams have been used.
DK	Yes	We have conducted 21 investigations/screenings at military areas, both historical sites and sites currently in use (Ministry of Defense's Property Management).*
DE	Yes	
FI	No/ Yes	No one here (ministry of the interior) knew PFAS before this. But now I know even something. According to Defense Command Finland, environmental studies have been made. A detailed inventory of fire-fighting foams is ongoing.
PL	(Yes)	
EE	Don't know	I have not heard about this issue, I do not know that there are any discussions about environmental issues.*
LV	Yes	
LT	Yes	After a major accident, when we use the foam we always have contact with the environment

3. Are there any restrictions and/or recommendations (actions to minimize the spread of PFAS in the environment) when using fire-fighting foams containing PFAS during training (*e.g. collection and destruction of fire-fighting waters*).		
Answer		Comment
SE	Yes	Recommendations: (1) use less PFAS- foams for the majority of fires (only use when no other alternative extinguishing methods are applicable).(2) collect and send for destruction (foams should be handled as hazardous waste)
DK	(Yes)	DEMA is considering doing a survey on which of the local authorities that uses AFFF. The idea is to have a centralised purchase agreement for fire-fighting foams and in this way control

		the use of AFFF (info from EPA). According to DEMA, the main focus has been on fire-fighting foams containing PFOS and PFOA that has been banned. The knowledge of other PFAS is very low
DE	(No)	There is no German restriction on AFFF. The federal states in Germany have developed different guidelines how to deal with fire-fighting waters. Some states developed threshold values for PFAS, so that fire-water needs to be collected (if possible) and properly disposed. I don't know if this is the case for all 16 Federal States
FI	No / Yes	Nothing from Ministry of the Interior. But rescue departments have got the instructions from the sellers of foams. Defense Command Finland: Use of firefighting foams is currently prohibited at fire training areas of airports. These areas are also used by military aviation fire crews.
PL	Yes	Restrictions arising from EU law
EE	Don't know	I don not know that there are any restrictions whene using PFAS-foams*
LV	-	
LT	Yes	To use less foam

4. Is there an ongoing discussion (at your organization or in your country in general) about any restrictions and/or measures when using fire-fighting foams containing PFAS, during practice?		
Answer		Comment
SE	Yes	The Swedish Chemical agency has submitted proposals of national regulations regarding PFAS foams (collections and destructions of foams during training)
DK	No /Don't know	This is currently not an issue that is high on the agenda in Denmark (DK EPA). As the knowledge that other PFAS could be a problem is limited it is not a discussion that has surfaced yet (DEMA).
DE	No	
FI	No/ Yes	Foam sellers are very well aware of this matter. According to them, foams In Finland are safe (Ministry of the Interior) It is an ongoing discussion according to Defense Command Finland
PL	No	-
EE	-	-
LV	-	-
LT	No	-

Contaminated soil

1. Has your country inventoried PFAS-contaminated soils? *(e.g. near fire training sites)*			
Answer		Comment	Respondent
SE	Yes	Yes it has been done. As a result of a new government assignment (regeringsuppdrag) further work is needed in this matter.	Swedish EPA
DK	Yes	Yes to some degree. The regions are responsible for mapping, investigating and remediating contaminated soil. The Danish EPA	Danish Regions Environment &

		established the first quality criteria for soil and drinking water for PFAS (sum of 12 compounds) in 2015. Thus mapping (inventorying) of PFAS contaminated soil has been required since. Danish Regions and the five regions are currently working on guidelines on how to conduct investigations at PFAS contaminated sites. The already conducted investigations are mainly screening level, but there are also examples of more detailed investigations (information from DK Regions).	Resources/ Danish EPA
DE	Yes	To limited extent only. Done under state responsibility, since the execution of federal soil policies is with the German Laender.	BMUB
FI	Yes	Sites with potential PFAS-contamination have been identified/inventoried (e.g. firefighting training sites, airports, military sites etc.), and several (but not all) of them have been (initially) characterized.	SYKE
PL	No	Unfortunately GIOŚ does not tests the PFAS /PFOS substances as part of the monitoring of groundwater's and soils in Poland.*	Ministry of the Environment, Department of Water Resources
EE	No	PFAS in soil is not regulated in Estonia. Estonia has not inventoried PFAS contaminated soils, we are mainly focused on past pollution (oil products, heavy metals) in soil resulted from past military action and industrial activities	Ministry of the Environment
LV	No	-	Ministry of Environmental Protection and Regional development of the Republic of Latvia
LT	No	-	Geological Survey of Lithuania

2. Does your country have an action plan or strategy for PFAS-contaminated soil? ***(e.g. systematic work for mapping, remediation and/or established methods for remediation of soil)***		
Answer		Comment
SE	Yes	The Swedish Geotechnical Institute (SGI) has developed threshold values for sensitive soil of 0,003 mg/kg dry weight and for less sensitive soil of 0,020 mg/kg dw
DK	(Yes)	Yes to some degree. As described above a strategy on how to conduct investigations is emerging. The regions are systematically mapping all contaminated soil; this as of 2015 includes soil contaminated with PFAS (DK Regions). The Danish EPA has sent letters to the local authorities, that they should be aware of possible ground water pollution near fire extinction sites. The Ministery of Defence has conducted an investigation of PFAS contamination at 21 sites (DK EPA)
DE	No	Yes and no. While there is no coordinated approach yet, there are some guideline papers with a focus on identification.
FI	(Yes)	We don't have a specific strategy for PFAS in soil, but actions have been targeted on identification and investigation of "risk sites/activities", where soil contamination often is a

		major contamination source (e.g. fire fight training sites).
PL	-	-
EE	No	Estonia has no action plan nor strategy for PFAS contaminated soil because main focus is on oil products and heavy metals in some areas resulted from past military and industrial actions
LV	No	-
LT	Yes	Action plan is the part of "Persistent organic pollutants (POPs) NIP 2017-2025". It should be soon approved by the Minister of Environment

3. Has your county at any time conducted a remediation of a PFAS-contaminated soil?		
Answer		Comment
SE	Yes	It depends on the definition of remediation. There have not been done any "permanent" remediation/treatments. There have only been some continues treatment methods in form of groundwater treatment. No excavation remediation arrangements have been made for PFOS with government grants. It is possible that there has been excavation during any exploitation, but I have unfortunately no information about it.*
DK	Yes	In context of the regions remediation activities are conducted at Copenhagen airport (the contamination on that site is being contained by pump and treatment by carbon filter). In addition there may be privately founded activities that I am not aware of (DK Regions).*
DE	Yes	Difficult topic due to the nature of the contaminants. Often soil removal and thermal treatment – need to develop more efficient *in situ* methods. Due to the lack of effective *in situ*-techniques and natural attenuation, 'dig and dump' und 'pump and treat' are conducted the most. This has been ok as long as pollution happened in defined, small areas and with a low number of contaminated sites. But with large scale pollution occurring we need alternative techniques. Presently, there are none available and we have to invest more into research.*
FI	Yes	I'm aware of only one site, where PFAS-contaminated soil was excavated and treated off-site. At the moment, there's no consensus on the acceptable risks regarding PFAS in soil (or groundwater) for which reason PFAS-contaminated soils are not systematically being remediated. Answers for the "risk questions" (e.g. in terms of acceptable risk levels; when is soil remediation needed and what are the required protection levels of different environmental media within a single site?) are being sought currently. The off-site "treatment" was indeed landfilling. So, not the most sustainable treatment approach (the POP limit value of 50 mg/kg was not exceeded and the soil included other contaminants as well).*
PL	-	-
EE	No	No PFAS-contaminated soil remediation projects in Estonia. We implement projects with the aim to clean past pollution with oil products and heavy metals
LV	Don't know	General comment: With regards to contaminated soils we would like to inform you that since 2002-2005 Register of Polluted and Potentially Polluted Sites was established and used for soil remediation purposes. However registration of polluted or potentially polluted

		sites was not and is not targeted and oriented on PFOS as separate polluter. What we can do in future when rehabilitation plans are going to be develop, and possible polluting substances are analyzed, PFOS issue can be taken 'on board' for places where such kind of polluter might be polluter of concern.
LT	No	-

4. Are there any ongoing/upcoming activities in your country specifically related to PFAS such, as regulation, monitoring or research etc.?		
Answer		Comment
SE	Yes	A new government assignment (regeringsuppdrag) which aims to develop new directions (vägledningar). There is also continues work to get guidance values for PFOS, PFAS.
DK	Yes	We are working on a guideline for conducting investigations at sites contaminated with PFAS (DK Regions). PFAS are included in the national program for monitoring of the state of the ground water (NOVANA) (DK EPA)
DE	Yes	Due to some recent and heavy soil contamination, e.g. in the south of Germany almost 500 ha of agri land have been contaminated through organic residues (compost mixed with paper mill residues from recycling paper), authorities have become more aware of the problem. A range of activities is done, but efforts are still not sufficient to cope with the problem.
FI	Yes	Ongoing R&D project related to site investigations and risk assessment of PFAS-contaminated firefighting training sites, and some national recommendations will be given based on that project. In addition, we have tried to increase the cooperation and information exchange within different stakeholder groups by setting up a specific PFAS expert group
PL	-	-
EE	No	-
LV	No	-
LT	Yes	Changes of regulations, inventory and monitoring are activities included to "Persistent organic pollutants (POPs) NIP 2017-2025". "According "POPs Management Program for Years 2017-2025" upcoming activities: -inventory of POPs potentialy contaminated sites (PCS) including PFAS; -Soil and Groundwater monitoring; -changes in regulation related to remediation of orphan sites contaminated with POPs.

Groundwater

1. Has your inventoried PFAS-contaminated groundwater? *(e.g. near fire training sites or landfills)*			
Answer		Comment	Respondent
SE	Yes	Potentially sources of PFAS has been inventoried. In the screening study (conducted by Swedish EPA) from 2016, 271 sites was identified (and analyzed). There are few measurements from waste facilities and landfills. SGU has conducted an inventory project in 2016 identifying new points of samplings (where PFAS are analyzed).	Swedish EPA/ Geological Survey of Sweden (SGU)
DK	Yes	We have done a screening project focusing PFAS as soil and	Danish EPA

		groundwater contamination in the form of point sources	
DE	Yes	According to UBA	UBA/ State Agency for Agriculture, Environment and Rural Areas of the German Federal State Schleswig-HolsteinDepartment of Waters Division of Groundwater Hydrology, Groundwater Protection; Division of Coastal Waters; Division of Streaming Waters and Ecology
FI	Yes	-	SYKE
PL	Don't Know/ No	Unfortunately GIOŚ does not tests the PFAS / PFOS substances as part of the monitoring of groundwater's and soils in Poland (Ministry of the Environment, Department of Water Resources).* We do not have data on PFOS/PFOA in groundwater of Baltic Sea Region in Poland (National Institute of Public Health)*	Chief Inspectorate of Environmental Protection/ Ministry of the Environment, Department of Water Resources / National Institute of Public Health
EE	No	-	Estonian Environment Agency
LV	No	-	Latvian Environment, Geology and Meteorology Centre
LT	No	-	Lithuanian Geological Survey

2. Has your country at any time detected PFAS in groundwater?		
Answer		Comment
SE	Yes	In a screening in 2016, 25 substances was detected (s. 75 in http://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6709-0.pdf?pid=17835)
DK	Yes	In small amounts below the Danish limit value (sum criteria of 0.1 µg/L for 12 PFASs)
DE	Yes/ No	According to UBA, detected substances: PFOA, PFHxA, PFPeA, PFBA, PFHpA, PFHxS, PFOS, PFBS, PFDA, PFNA, 6:2 FTS, PFHpS, 8:2 FTS, 10:2 FTS, PFUnA, PFDoA, PFOSA, 4:2 FTS, PFDS. According to the Federal State of Schleswig-Holstein, In our state-wide chemical monitoring, we regulary don't analyse PFOA/PFOS. We have no data about the occurrence of these substances in groundwater in Schleswig-Holstein.*

FI	Yes	Contaminated sites (fire training): 18 of the 23 of the analysed PFAS were above LOQ. The most abundant compounds were PFOS, PFHxS, PFOSA, and 6:2 FTS (LOQ = 0.1 – 0.5 ng/l)
PL	Don't know/ No	
EE	No	-
LV	No	Maybe there could be some groundwater screening project, but as we have not found EQS exceedances in surface water biota, then it is not suspected to be found in groundwater.
LT	No	-

3. Does your country monitor PFAS in groundwater on a regular basis?		
Answer		Comment
SE	(No)	If PFAS is detected in an inventory (and the point is included in a sampling program) the substances are analyzed continuously. Measurements based on the type of contamination (risk) are conducted by SGU. A few sites at the moment are of the type PFAS (mostly PFOS).
DK	Yes	Sum criteria of 0.1 µg/L for: PFBS, PFHxS, PFOS, PFOSA, 6:2 FTS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA and PFDA for groundwater used as drinking water
DE	No	According to UBA, it differs very between the German Federal States. No data are available for Schleswig-Holstein and Mecklenburg-Vorpommern.
FI	No	A project called PFARA which focuses on risk management actions at PFAS contaminated sites and includes measurements of PFAS in groundwater.
PL	No	-
EE	No	-
LV	No	-
LT	No	-

4. Are there available measurements of PFAS in groundwater from screening studies and/or research or other projects?		
Answer		Comment
SE	Yes	Close to fire training sites PFAS was detected in 89% of the samples (median and mean of 171 and 24 463ng/L , respectively). At locations without direct sources (diffuse sources) PFAS was found in 40% of the samples (median and mean of 11.4 and 23.5 ng/L, respectively). http://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6709-0.pdf?pid=17835
DK	Don't know	-
DE	Don't know	-
FI	No	-
PL	Don't know	-

EE	No	-
LV	No	-
LT	No	-

5. Has your country established threshold values for PFAS in groundwater?		
Answer		Comments
SE	Yes	45 ng/l for PFOS
DK	Yes	Sum criteria of 0.1 µg/L for: PFBS, PFHxS, PFOS, PFOSA, 6:2 FTS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA and PFDA. The threshold is for groundwater used as drinking water. However, it can also be used for evaluation of groundwater at contaminated areas*
DE	No	There are activities going on to derive so called "insignificance thresholds for groundwater" for some PFC in. These values are under discussion and will not (jet) be legally binding.
FI	No	Are about to start the process of defining an EQS for PFAS in groundwater*
PL	No	-
EE	No	-
LV	No	-
LT	No	-

Drinking Water

1. Has your country at any time detected PFAS in drinking water?			
Answer		Comments	Respondent
SE	Yes	PFAS has been detected in several screening studies. Measurements 2000-2015: 1500 samples where PFASs was detected in 20% of the samples and 14 % of these samples from drinking water had higher concentrations than 90 ng/L (16% in raw water) http://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6709-0.pdf?pid=17835.	Swedish EPA
DK	Yes	PFAS has been detected in ground water used for drinking water.	Danish EPA
DE	Yes	Beginning in 2006 in the context of a screening study. https://www.umweltbundesamt.de/sites/default/files/medien/419/dokumente/pft-im-trinkwasser.pdf (in German).	UBA
FI	Yes	10 of the 18 analysed PFCAs and PFSAs were above LOQ (LOQ = 0.1 – 0.5 ng/l), and at least one compound above LOQ in 40 % of the samples. The data is from a screening study from 2015-2016.	SYKE
PL	Yes	I am not able to give you the details you expect, simply because the problem has been not adequately studied in Poland. The PFOS/PFOA levels in drinking water as well as water abstracted for public network supply have not been studied systematically and thoroughly. The results of preliminary and fragmentary studies of drinking water in large cities (supplied predominantly by surface waters) revealed the	Institute of Environmental Health (Environmental Hygiene Department)/

		relative low PFOS/PFOA levels, especially when compared to food. As a result it has been admitted that drinking water is not a significant source of exposure to these substances and no attempt has been taken to determine the levels in a more systematic way, including groundwater. So, in Poland the problem is far from being elucidated up to now and further studies are required (Institute of Environment Health Environmental Hygiene Department).*	Chief Sanitary Inspectorate (Department of Water Health Safety)
EE	No	No measurements	Health Board
LV	Don't know	We don`t have information on possible appearance of those substances in drinking water and such kind of discussions is not raised in Latvia.	Health Inspectorate, Chief specialist in the environmental health issues
LT	-	-	National Public Health

2. Is there regular monitoring of PFAS in drinking water in your country?		
Answer		Comments
SE	(No)	If drinking water system is or is suspected to be affected by PFAS, the concentrations in the drinking water should be investigated. Screening studies has been
DK	Yes	According to a revised drinking water regulation, which will probably come into force during autumn, PFAS will be regularly measured in drinking water.
DE	No	No, but some of Germany's 16 states conduct surveys. https://www.lgl.bayern.de/lebensmittel/warengruppen/wc_59_trinkwasser/ue_2009_trinkwasser_pft.htm
FI	No	-
PL	No	-
EE	No	-
LV	No	The Drinking Water Directive does not require monitoring of PFAS/PFOS in drinking water and we are not performing such kind of monitoring.
LT	No	NPHSL does not perform any PFAS tests on drinking water since there are no EU-regulations on these substances.

3. Has your country established indicative threshold values for PFAS in drinking water?		
Answer		Comments
SE	Yes	The Swedish Food Agency has recommended, based on analysis of 11 PFAS, that the concentration of PFAS-11 should be below 90 ng/Liter in drinking water. At concentrations above 900 ng/L, the water should not be consumed.
DK	Yes	Sum of PFAS substances: 0.1 µg/l. PFAS substances are: PFBS, PFHxS, PFOS, PFOSA, 6:2 FTS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA og PFDA.
DE	Yes	Depending on the available toxicological data, there are Guidance values (GV) for some and health-based orientation values (GOW) for others, as follows GV or GOW in µg/l:

		PFBA- GV: 10 PFPeA- GOW: 3,0 PFHxA- GV: 6 PFHpA- GOW: 0,3 PFOA- GV: 0,1 PFNA- GV: 0,06 PFDA- GOW: 0,1 PFBS- GV: 6 PFHxS- GV: 0,1 PFHpS- GOW: 0,3 PFOS - GV: 0,1 H4PFOS - GOW: 0,1 PFOSA -GOV: 0,1 https://www.umweltbundesamt.de/sites/default/files/medien/374/dokumente/fortschreibung_der_uba-pfc-bewertungen_bundesgesundheitsbl_2017-60_s_350-352.pdf
FI	No	The ministry of social affairs and health is drafting an indicative threshold value for PFAS in drinking water.
PL	No	
EE	No	-
LV	-	-
LT	-	-

4. Does your country monitor PFAS in waters bodies used as source for drinking water? *(e.g. in groundwater and/or surface water)*		
Answer		Comments
SE	No	PFAS has previously not been measured in a greater extent in groundwater and surface water used as drinking water, but in the recent years some water producers, the Swedish water and the Swedish EPA has conducted some measurements. Measurements from 2016: groundwater and surface water used as drinking water PFAS was detected in 73 and 100%, respectively. However, only 35% of water sources has been analyzed for PFAS
DK	Yes	
DE	Don't know	
FI	(Yes)	Yes and no, because surface waters in general are monitored, but not specifically those that are sources of drinking water.
PL	No	
EE	No	Estonia isnt currently monitoring PFAS in drinking water or drinking water sources*
LV	-	-
LT	-	-

5. Has your country estimated how many people may be/have been exposed to PFAS through drinking water?

Answer		Comments
SE	Yes	The Swedish EPA estimated that 300 000 people may have been exposed to PFAS (7 substances) at concentrations above 90 ng/L (from water supplies) at least at some occasion.
DK	No	-
DE	No	
FI	No	-
PL	-	-
EE	No	-
LV	-	-
LT	-	-

Environmental Data

1. Is PFOS included in regular environmental monitoring?			
Answer		Comments	Respondent
SE	Yes	Biota (freshwater and marine), air, effluents and sludge from STPs.	Swedish EPA
DK	Yes	Surface water (rivers), sediment (lakes), biota (marine water) (2010-2016). Biota (rivers, lakes and marine water), groundwater (2017-2021). There are no measurements/ monitoring of PFAS in air samples in Denmark	Environmental Protection Agency
DE	Yes	According to the Oberflächengewässer Verordnung (OgewV, 2016, implementing the WFD) PFOS has to be monitored in biota (fish) and water from 2018 in surface, transitional and coastal waters.	UBA
FI	Yes	PFOS included in fish monitoring (WFD and MSFD). Target species are perch and herring.	SYKE
PL	Yes	Biota (muscle). Results reported to ICES; Biota inland waters - whole fish, muscle tissue of fish in marine waters, Sediments (inland waters) – results can be accessed on demand.	Institute of Meteorology and Water Management, National Research Institute; Chief Inspectorate of Environmental Protection
EE	Yes	PFOS is going to be monitored in freshwater, marine waters, sediment and boita (marine and freshwater boita both).* In 2017 PFOS are in regular environmental monitoring for the first time so we don't have the results yet.	Estonian Environment Agency
LV	Yes	We have started monitoring of PFOS and PFOA in biota (fish *Perca fluviatilis*) in year 2015. Results can be found in annual surface and ground water quality reports (*in Latvian*) Annual report 2015 Report for results of year 2016 will be published at the end of September 2017.	Environment, Geology and Meteorology Centre
LT	Yes	PFOS is included in National Environmental Monitoring Programme and is monitored in water, sediments and biota of	Environmental Protection Agency

		inland surface waters, transitional waters (Curonian Lagoon) and Baltic Sea. Monitoring data is reported under SoE on WISE and ICES.	

2. Are other PFAS included in regular environmental monitoring?		
Answer		Comments
SE	Yes	Air: PFOA (will be extended to several substances) STPs: PFBA, PFPA, PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUna; PFDoA, PFBS, PFHxS, PFDS, PFOSA Biota: PFHxA, PFHpA, PFOA, PFNA, PFDA, PFUnDA, PFDoDA, PFTrDA, PFTeDA, PFPeDA, PFBS, PFHxS, PFDS and FOSA
DK	Yes	PFUnA, PFNA, PFOA, PFOSA, PFDA , PFHxS surface water, sediment, biota (2010-2016). Biota (rivers, lakes and marine water) (2017-2021) In groundwater: PFBS, PFHxS, PFOS, PFOSA, 6:2 FTS, PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFNA and PFDA
DE	No	In Germany the Länder (Federal States) are responsible for implementing the water legislation and are monitoring according to the requirements of the WFD, OSPAR, HELCOM and the MSFD. But in addition they are monitoring many more substances on a more or less regular basis or in screening studies* The Federal States are responsible to monitor PFOS (according to OGewV (WFD, OSPAR, HELCOM and MSFD) but the Federal States include several more PFAS substances in monitoring or in screening studies. For example, in Mecklenburg Vorpommern, the monitoring report (year 2015) includes 18 PFAS in marine and freshwater species. In Schleswig-Holstein the first PFOS measurements under the WFD surveillance monitoring began in 2016 in coastal waters of the North Sea (4 stations, 7 samplings) and the Baltic Sea (4 stations, 6 samplings). The accompanying data will be uploaded into national marine database (MUDAB) during 2017 and then further to the ICES database. The monitoring of PFOS in freshwater was only undertaken sporadically. The monitoring of biota in Schleswig-Holstein was conducted in 2013 and 2016 in 8 rivers and 6 lakes. Some samples exceeded the EQS (summarized from several emails).*
FI	Yes	Always measured along PFOS in SYKE Laboratory PFCAs: C_4-C_{14}, C_{16}, C_{18} PFSAs: C_4, C_6-C_8, C_{10} Recently also PFOSA, Et-PFOSA, and 4, 6 and 8:2 FTS
PL	No	-
EE	No	-
LV		
LT	No	Measurements of PFOA in inland surface waters were performed just in 2014.

3. Are there available measurements of PFAS from screening studies/ research/ other projects?		
Answer		Comments
SE	Yes	Several studies (screenings and research) on different environmental matrixes.

		Nearly 40 substances (historically and new measurements, 6100 samples) was compiled in 2016. Including matrixes of freshwater, freshwater and marine fish, mammals, storm water, sewage water, landfill leaches and soil, http://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6709-0.pdf?pid=17835
DK	Yes	Screening from 2007 shows that the occurrence of several PFAS and organotin compounds are widespread at point sources and in the aquatic environments in Denmark http://www.dmu.dk/Pub/FR608.pdf. Screening from 2014 investigating the presence of PFAS at groundwater contamination associated with point sources http://www2.mst.dk/Udgiv/publikationer/2014/10/978-87-93178-96-0.pdf
DE	Yes	We are not able to refer to all research and screening studies conducted in Germany, therefore we have focused on the regular monitoring obligations.*
FI	Yes	(1) There will be results from 11 rivers with 8 monthly samples (11/2016 – 8/2017) http://www.syke.fi/hankkeet/uupri, (2) Fish screening by food authorities is underway 2016-2018, similarly to 2009-2010 (Koponen et al. 2015). (3) There was an extensive survey of WFD substances (incl PFOS) in WWTP effluents in Finland in 2013 :https://www.vvy.fi/vesihuolto_linkit_lainsaadanto/jatevedet/haitalliset_aineet_-hanke_2013 (4) And a smaller one (capital area) on sludges: Vieno, N. 2015. Haitta-aineet puhdistamo- ja hajalietteissä. Julkaisu 73/2015. (5) PFCAs and PFSAs in sludge, soil and earthworms in RUSSOA project (http://hdl.handle.net/10138/169282).
PL	Don't know	-
EE	Yes	Surface water, marine waters, biota and WWTP. PFHxA, PFOS , PFOA and PFDA
LV	Yes	PFOS and PFOA were analysed during national screening project in 2016 "*Bīstamu ķīmisku vielu apsekojums Latvijas virszemes ūdeņos*" (Survey of hazardous chemical substances in Latvian surface waters), PFAS substances were analysed in 5 largest WWTP effluents. Concentrations did not exceed MAC-EQS value, but were above AA-EQS value (0.65 ng/L).
LT	Yes	During the project "Strengthening of marine and inland water management – part one", which was implemented by the LT02 program "Integrated marine and inland water management" (funded by the EEA Financial Mechanism 2009–2014) PFOS and PFOA were measured in water, sediments and biota of the Baltic Sea, Curonian Lagoon and inland waters and also in wastewater of different economic activities in 2015. Measurements of PFOS in wastewater of different economic activities was performed during "BaltActHaz" project in 2009-2012.

4. Has Your country established threshold values (e.g. EQS) for any PFAS other than PFOS?		
Answer		Comments
SE	No	Currently, the VATTENMYNDIGHETERNA has proposed a EQS for the summary of 11 PFAS in groundwater which will be established in 2018
DK	(Yes)	For drinking water and soil (summary of 12 PFASs)
DE	No	
FI	No	In progress for groundwater /drinking water

PL	Don't know	-
EE	No	-
LV	No	-
LT	No	-

5. Has the AA-EQS for PFOS in surface water (of 0.65 ng/L given in WFD) been exceeded in your country at any time?		
Answer		Comments
SE	Yes	Several of times
DK	Yes	
DE	-	The limit of quantification exceeds for most of the available monitoring data the EQS therefore reliable assessment of the monitoring results is not possible
FI	Yes	River Vantaanjoki
PL	No	-
EE	No/ Don't know	The analytical methods do not allow this accuracy
LV	No	PFOS is not monitored in surface water, but in biota. As biota EQS value is not exceeded, analysis of water samples has not been considered. Assessment of waterbody chemical quality is based on results in biota monitoring.
LT	Yes	During the project "Strengthening of marine and inland water management – part one", PFOS AA-EQS values were exceeded in some of the monitoring stations of the Curonian Lagoon and the Baltic Sea and also insignificantly in few inland water stations.

6. Has the AA-EQS for PFOS in biota (9.1 µg/kg given in WFD) been exceeded in your country at any time?		
Answer		Comments
SE	Yes	In measurements form 2000-2015 AA-EQS for biota was exceeded in 60% of the cases near fire fighting sites.
DK	Yes	
DE	-	A reliable assessment will be possible when more biota data are available
FI	Yes	Two different sites: perch 2009 and 2015 One "close to" in 2015 All in Uusimaa area (Nyland)
PL	Yes	According to The Chief Inspectorate of Environmental Protection – in about 3% of samples collected in 2016 (6 out of 200 samples).
EE	No	
LV	No	-
LT	No	No, all measured values of PFOS in biota didn't exceed AA-EQS (biota).

NATUR VÅRDS VERKET

SWEDISH ENVIRONMENTAL PROTECTION AGENCY

EUSBSR EU STRATEGY FOR THE BALTIC SEA REGION

POLICY AREA 'HAZARDS'

PFAS in the Baltic Sea Region: Inventory of awareness, actions and strategies related to highly fluorinated substances, PFAS, including PFOS

During the last decade, highly fluorinated substances (PFAS) have been found globally in humans, wildlife and in the environment. PFAS are hazardous to human health and the environment as many of them bioaccumulate and are toxic. They are highly persistent pollutants, but also relatively water soluble and mobile. These properties are unique compared to many other environmental pollutants. PFAS have been used since the early 1950's in various products and industrial processes. Today about 3000 various PFAS are in use. Most attention has been given to the substances PFOS and PFOA, however lately also other PFAS are recognized as environmental contaminants.

Due to a common interest among the Baltic Sea countries, and to inform national and regional policy stakeholders, the Policy Area Hazards of the EU Strategy for the Baltic Sea Region, has performed an inventory of the awareness, actions and strategies related to PFAS in the environment in all EU-Baltic Sea Region countries. Based on voluntary participations, this inventory collected information regarding knowledge and awareness of the emerging threat posed by PFAS to human health and the environment, national policies, and measures already taken or planned regarding PFAS-pollution within the region.

The inventory shows that awareness, strategies and activities related to PFAS vary significantly between countries in the region. Some countries limit their activities to meet European Union regulations, while others have initiated national and transnational cross-sectorial dialogues. Substantial screenings, inventories and monitoring of sources, environmental contamination and human exposure have been done or are planned in several countries. All countries stress the lack of knowledge.

The results of the inventory can serve as a good basis for future work in the Baltic Region to increase knowledge of environmental levels of PFAS, better control of discharges and limit human exposure. It is recommended to increase the exchange of knowledge, experiences and best practices within the Baltic Sea Region using existing networks.

Interreg Baltic Sea Region

EUROPEAN UNION
EUROPEAN REGIONAL DEVELOPMENT FUND